Perspectives on Incentive Spirometry Utility and Patient Protocols

Adam E M Eltorai MSc, Grayson L Baird PhD, Ashley Szabo Eltorai MD, Joshua Pangborn, Valentin Antoci Jr MD PhD, H Allethaire Cullen MSN RN, Katherine Paquette PhD RN, Kevin Connors RRT CPFT, Jacqueline Barbaria RRT, Kimberly J Smeals RRT, Saurabh Agarwal MD, Terrance T Healey MD, Corey E Ventetuolo MD MS, Frank W Sellke MD, and Alan H Daniels MD

BACKGROUND: Incentive spirometry (IS) is widely used to prevent postoperative pulmonary complications, despite limited clinical effectiveness data and a lack of standardized use protocols. We sought to evaluate health care professionals' perspectives on IS effectiveness and use procedures. METHODS: An online survey was distributed via social media and newsletters to relevant national nursing and respiratory care societies. Attitudes concerning IS were compared between the American Association for Respiratory Care (AARC) and the nursing societies. RESULTS: A total of 1,681 responses (83.8% completion rate) were received. The clear majority of these respondents agreed that IS is essential to patient care (92.7%), improves pulmonary function (92.0%), improves inspiratory capacity (93.0%), helps to prevent (96.6%) and to reverse (90.0%) atelectasis, helps to prevent (92.5%) and to reverse (68.4%) pneumonia, and is as effective as early ambulation (74.0%), deep-breathing exercises (88.2%), and directed coughing (79.8%). Furthermore, most health care professionals believed that IS should be used routinely preoperatively (78.1%) and postoperatively (91.1%), used every hour (59.8%), used for an average of 9.6 (95% CI 9.3–9.9) breaths per session, used to achieve breath holds of 7.8 (95% CI 7.4–8.2) s, used to reach an initial target inspiratory volume of 1,288.5 (95% CI 1,253.8–1,323.2) mL, and used to achieve a daily inspiratory volume improvement of 525.6 (95% CI 489.8–561.4) mL. Of all respondents, 89.6% believed they received adequate IS education and training. Respondents from the AARC endorsed significantly less agreement relative to the nursing societies on most parameters for IS utility. CONCLUSIONS: There was a major discrepancy between health care professionals' beliefs and the published clinical effectiveness data supporting IS. Despite reported adequate education on IS, variability in what health care professionals believed to be appropriate use underscores the literature's lack of standardization and evidence for specific use procedures. *Key words: incentive spirometry; nurse; respiratory therapy; postoperative care; perspectives.* [Respir Care 2018;63(5):519–531. © 2018 Daedalus Enterprises]

Introduction

In the United States, 95% of hospitals report prescribing postoperative incentive spirometry (IS).[1] IS is ordered for patients at risk for postoperative pulmonary complications to reduce that risk.[2-4] According to the American Association for Respiratory Care (AARC),[5] IS is indicated for

Drs Baird, Antoci, Agarwal, Healey, Ventetuolo, Sellke, and Daniels, as well as Messrs Eltorai and Pangborn, are affiliated with the Warren Alpert Medical School of Brown University, Providence, Rhode Island. Drs Baird and Ventetuolo, as well as Mr Connors, Ms Barbaria, and Ms Smeals, are affiliated with Rhode Island Hospital, Providence, Rhode Island. Dr Eltorai is affiliated with Yale University School of Medicine, New Haven, Connecticut. Ms Cullen is affiliated with the Community College of Rhode Island, Warwick, Rhode Island. Ms Paquette is affiliated with the University of Rhode Island, Kingston, Rhode Island.

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Correspondence: Adam E M Eltorai MSc, Warren Alpert Medical School of Brown University, 100 Butler Drive, Providence, RI 02906. E-mail: adam_eltorai@brown.edu.

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patients with atelectasis and for those with the following risk factors for atelectasis: thoracic or abdominal surgery,[2] coronary artery bypass graft surgery,[67] patients wearing binders on the thorax or abdomen, prolonged bed rest, COPD, poor pain control,[8] neuromuscular lung disease, inspiratory capacity < 2.5 L,[9] spinal cord injuries, and sickle cell patients with acute chest syndrome.[8,10] There are no IS guidelines from the American Thoracic Society. The AARC guidelines[5] describe a procedure of sustaining maximal inhalation for 5 s.

However, numerous studies including controlled trials have demonstrated that IS alone is inadequate in reducing postoperative pulmonary outcomes.[6,11-14] Early mobilization, deep-breathing exercises, directed cough, and adequate pain management appear to reduce postoperative pulmonary complications[15-17] with or without IS after cardiothoracic surgery[18-24] and abdominal surgery.[25-31] In combined analyses,[22,28,32-35] IS has repeatedly failed to demonstrate evidence of lung volume improvement or postoperative pulmonary complication reduction. Furthermore, there are few outcome-based data supporting precisely how IS should be used. Previous investigations themselves have used widely variable procedural parameters with respect to the optimal frequency of sessions,[8,11,14,26,36-51] target inspiratory volume,[14,40,43,44] whether the target is static or dynamic,[11,14,40,42] when to start IS postoperatively,[11,37,39,40,43,44,47,50] the number of breaths per session,[8,14,26,36-38,42,43,45,46,49,52,53] and duration of breath holds.[5,12,14,26,40,42,44,48]

Given their continued widespread usage, the paucity of effectiveness data, and an absence of standardized use protocols, the purpose of this study was to evaluate health care professional perspectives on IS utility and use procedures.

QUICK LOOK

Current knowledge

Incentive spirometry (IS) is widely used to prevent postoperative pulmonary complications. There are limited clinical efficacy data and a lack of standardized use protocols.

What this paper contributes to our knowledge

There was a major discrepancy between providers' beliefs and the published clinical efficacy data supporting IS. Despite reported adequate education on IS, variability in what providers believed to be appropriate use underscores the literature's lack of standardization and evidence for specific use procedures.

Methods

A Lifespan Corporation (Providence, Rhode Island) institutional review board–exempt, anonymous, online survey created in REDCap[54] was distributed from September 2016 to December 2016 via social media and newsletters to the following national nursing and respiratory care societies: Academy of Medical-Surgical Nurses (AMSN), American Association of Critical-Care Nurses (AACN), American Society of Peri-Anesthesia Nurses (ASPAN), and American Association for Respiratory Care (AARC). AMSN is a nursing specialty organization of > 11,500 medical-surgical nurses. With > 100,000 members, AACN is a nursing specialty organization of acute and critical care nurses. ASPAN has > 15,000 members and is a professional organization focused on peri-anesthesia nursing. With > 52,000 members, AARC is a professional organization for respiratory care. Survey instructions indicated that the goal of the investigation was to understand health care professionals' perspectives on the use of IS in their clinical practices and to explore health care professionals' understanding of IS, reflecting actual implementation of IS in patient care.

Analyses were conducted using SAS Software 9.4 (SAS, Cary, North Carolina). Frequencies and percentages were calculated using PROC FREQ, and, for ease of summarization, means and medians were also calculated. Because Likert-scale responses were between 1 and 6, means were calculated using generalized linear modeling, assuming a binomial distribution, thus allowing confidence intervals to be asymmetrical. Mean estimates of count and time were estimated using generalized linear modeling, assuming a negative binomial distribution. All modeling was accomplished using GLIMMIX. Medians were calculated with PROC MEANS. All interval estimates were calculated for 95% confidence. Finally, post hoc comparisons were made to explore differences between respiratory therapists (AARC) and nurses (ASPAN, AACN, AMSN). Multiple comparisons were made using generalized linear modeling assuming a binomial distribution with Bonferroni corrections. Alpha was set at the 0.05 level for all analyses, and all interval analyses were calculated for 95% confidence.

Results

There were 1,681 unique respondents from the 4 national organizations. The respondents included respiratory therapists and nurses with various educational backgrounds, years of experience, and primary practice locations (Table 1). Survey completion rates were 80.3% for AARC, 84.3% for ASPAN, 84.8% for AMSN, and 90.1% for AACN. Given the distribution methodology, the exact response rates cannot be determined due to the inability to identify the total number of individuals the survey may have reached.

Table 1. Respondent Characteristics

	Response Options	AARC *n/N* (% respondents)	ASPAN *n/N* (% respondents)	AMSN *n/N* (% respondents)	AACN *n/N* (% respondents)	Aggregated *n/N* (% respondents)
Position	Nurse	2/374 (0.5)	804/806 (99.8)	278/278 (100)	106/106 (100)	1190/1,564 (76.1)
	RT	372/374 (99.5)	2/806 (0.2)	0/278 (0)	0/106 (0)	374/1,564 (23.9)
Highest degree	Nurse - Diploma	0/2 (0)	56/788 (7.1)	8/272 (2.9)	3/102 (2.9)	67/1,164 (5.8)
	Nurse - ADN	2/2 (100)	114/788 (14.5)	46/272 (16.9)	7/102 (6.9)	169/1,164 (14.5)
	Nurse - LPN	0/2 (0)	1/788 (0.1)	0/272 (0)	0/102 (0)	1/1,164 (0.1)
	Nurse - BSN	(0/2 (0)	469/788 (59.5)	144/272 (52.9)	63/102 (61.8)	676/1,164 (58.1)
	Nurse - MSN	0/2 (0)	114/788 (14.5)	57/272 (21)	20/102 (19.6)	191/1,164 (16.4)
	Nurse - DNP	0/2 (0)	3/788 (0.4)	1/272 (0.4)	4/102 (3.9)	8/1,164 (0.7)
	Nurse - PhD	0/2 (0)	2/788 (0.3)	6/272 (2.2)	4/102 (3.9)	12/1,164 (1)
	Nurse - other	0/2 (0)	29/788 (3.7)	10/272 (3.7)	1/102 (1)	40/1,164 (3.4)
	RT - AS	174/356 (48.9)	0/1 (0)	NA	NA	174/357 (48.7)
	RT - BS	182/356 (51.1)	1/1 (100)	NA	NA	183/357 (51.3)
Years in practice, mean ± SD (*n* respondents)	NA	368 (21.4 ± 13.5)	795 (26.8 ± 11.1)	279 (17.6 ± 12.8)	104 (15.7 ± 12.6)	1,546 (23.1 ± 12.1)
Primary practice location, % (*n/N* respondents)	PACU	1/350 (0.3)	670/783 (85.6)	1/276 (0.4)	3/102 (2.9)	675/1,511 (44.7)
	ICU	148/350 (42.3)	7/783 (0.9)	5/276 (1.8)	64/102 (62.7)	224/1,511 (14.8)
	Step-down unit	18/350 (5.1)	3/783 (0.4)	21/276 (7.6)	17/102 (16.7)	59/1,511 (3.9)
	Medical/surgical wards	124/350 (35.4)	14/783 (1.8)	230/276 (83.3)	15/102 (14.7)	383/1,511 (25.3)
	Rehab	20/350 (5.7)	1/783 (0.1)	2/276 (0.7)	1/102 (1)	24/1,511 (1.6)
	In-home	4/350 (1.1)	0/783 (0)	2/276 (0.7)	0/102 (0)	6/1,511 (0.4)
	Other	35/350 (10.0)	88/783 (11.2)	15/276 (5.4)	2/102 (2)	140/1,511 (9.3)

AARC = American Association for Respiratory Care
ASPAN = American Society of Peri-Anesthesia Nurses
AMSN = Academy of Medical-Surgical Nurses
AACN = American Association of Critical-Care Nurses
RT = respiratory therapist
NA = not applicable
PACU = post-anesthesia care unit

However, based on organization-reported memberships, estimated response rates were 5.4% for ASPAN, 2.4% for AMSN, 0.7% for AARC, and 0.1% for AACN.

From the survey responses, the clear majority of health care professionals agreed that IS is essential to patient care (92.7%; 1,531 of 1,651 respondents) (Table 2). Most health care professionals agreed that IS improves pulmonary function (92.0%; 1,511 of 1,643 respondents) and improves inspiratory capacity (93.0%; 1,525 of 1,639 respondents) (Table 3). Most health care professionals agreed that IS helps to prevent (96.6%; 1,593 of 1,650 respondents) and to reverse (90.0%; 1,477 of 1,641 respondents) atelectasis, and IS helps to prevent (92.5%; 1,522 of 1,646 respondents) and to reverse (68.4%; 1,117 of 1,632 respondents) pneumonia (Table 4). Most health care professionals agreed that IS is as effective as early ambulation (74.0%; 1,214 of 1,641 respondents), deep-breathing exercises (88.2%; 1,456 of 1,650 respondents), and directed coughing (79.8%; 1,308 of 1,640 respondents) (Table 5). Most health care professionals agreed that IS should be used routinely preoperatively (78.1%; 1,281 of 1,640 respondents) and postoperatively (91.1%; 1,504 of 1,651 respondents) (Table 6).

Most health care professionals agreed that IS should be used every hour (59.8%; 961 of 1,606 respondents). Health care professionals believed an average of 9.6 (95% CI 9.3–9.9) breaths should be taken per session, with breath holds of 7.8 (95% CI 7.4–8.2) s, initial target inspiratory volume of 1,288.5 (95% CI 1,253.8–1,323.2) mL, and daily inspiratory volume improvement of 525.6 (95% CI 489.8–561.4) mL. In terms of appropriate use, 51.1% (829 of 1,621) of respondents believed that achieving target inspiratory volume is the most important factor, with piston hovering in the "smiley-face" zone to be the target inspiratory flow (72.5%; 1,176 of 1,623 respondents) (Table 7). Most respondents believed they received adequate IS education and training (89.6%; 1,474 of 1,645 respondents) (Table 8).

Finally, attitudes concerning IS were compared between AARC and the nursing societies. As seen in the estimates in Tables 2–6 and 8, AARC members endorsed significantly less agreement relative to the nursing societies concerning the following statements:

- IS is essential for patient care ($P < .001$).
- IS improves pulmonary function ($P < .001$).
- IS improves inspiratory capacity ($P < .001$).
- IS helps to prevent atelectasis ($P < .001$).
- IS helps to reverse atelectasis ($P < .001$).
- IS helps to prevent pneumonia ($P < .0001$).
- IS helps to reverse pneumonia ($P < .001$).
- IS should be used routinely preoperatively ($P < .001$).

Table 2. Importance of IS

	Agreement	Response Options (Score)	AARC, *n* (%)	ASPAN, *n* (%)	AMSN, *n* (%)	AACN, *n* (%)	Aggregated *n* (%)	
IS is essential for patient care	Agree	Strongly agree (1)	115 (28.4)	373 (44.6)	157 (52.0)	49 (45.8)	694 (42.0)	1,531 (92.7)
		Agree (2)	119 (29.4)	294 (35.1)	106 (35.1)	35 (32.7)	554 (33.6)	
		Somewhat agree (3)	95 (23.5)	141 (16.9)	30 (9.9)	17 (15.9)	283 (17.1)	
	Disagree	Somewhat disagree (4)	25 (6.2)	17 (2.0)	6 (2.0)	4 (3.7)	52 (3.2)	120 (7.3)
		Disagree (5)	29 (7.2)	12 (1.4)	2 (0.7)	1 (0.9)	44 (2.7)	
		Strongly disagree (6)	22 (5.4)	0 (0)	1 (0.3)	1 (0.9)	24 (1.5)	
	Mean (95% CI), median		2.5 (2.4–2.6), 2	1.8 (1.8–1.9), 2	1.7 (1.6–1.7), 1	1.8 (1.7–2.0), 2	1.6 (1.5–1.7), 2	

For AARC, $N = 405$; for ASPAN, $N = 837$; for AMSN, $N = 302$; for AACN, $N = 107$. Aggregated $N = 1,651$.
IS = incentive spirometry
AARC = American Association for Respiratory Care
ASPAN = American Society of Peri-Anesthesia Nurses
AMSN = Academy of Medical-Surgical Nurses
AACN = American Association of Critical-Care Nurses

Table 3. Utility of IS

	Agreement	Response Options (Score)	AARC, *n* (%)	ASPAN, *n* (%)	AMSN, *n* (%)	AACN, *n* (%)	Aggregated *n* (%)	
IS improves pulmonary function	Agree	Strongly agree (1)	81 (20.2)	391 (46.9)	156 (51.8)	53 (49.5)	681 (41.5)	1,511 (92.0)
		Agree (2)	115 (28.7)	340 (40.8)	119 (39.5)	44 (41.1)	618 (37.6)	
		Somewhat agree (3)	106 (26.4)	74 (8.9)	23 (7.6)	9 (8.4)	212 (12.9)	
	Disagree	Somewhat disagree (4)	39 (9.7)	14 (1.7)	2 (0.7)	0 (0)	55 (3.4)	132 (8.0)
		Disagree (5)	43 (10.7)	15 (1.8)	0 (0)	0 (0)	58 (3.5)	
		Strongly disagree (6)	17 (4.2)	0 (0)	1 (0.3)	1 (0.9)	19 (1.2)	
	Mean (95% CI), median			2.7 (2.6–2.9), 3	1.7 (1.7–1.8), 2	1.6 (1.5–1.7), 1	1.6 (1.5–1.8), 2	1.9 (1.9–2.0), 2
IS improves inspiratory capacity	Agree	Strongly agree (1)	86 (21.6)	391 (46.9)	139 (46.3)	49 (45.8)	665 (40.6)	1,525 (93.0)
		Agree (2)	135 (33.9)	333 (39.9)	128 (42.7)	41 (38.3)	637 (38.9)	
		Somewhat agree (3)	106 (26.6)	78 (9.4)	25 (8.3)	14 (13.1)	223 (13.6)	
	Disagree	Somewhat disagree (4)	31 (7.8)	23 (2.8)	5 (1.7)	0 (0)	59 (3.6)	114 (7.0)
		Disagree (5)	29 (7.3)	9 (1.1)	2 (0.7)	0 (0)	40 (2.4)	
		Strongly disagree (6)	11 (2.8)	0 (0)	1 (0.3)	3 (2.8)	15 (0.9)	
	Mean (95% CI), median		2.5 (2.4–2.6), 2	1.7 (1.7–1.8), 2	1.7 (1.6–1.8), 2	1.8 (1.6–2.0), 2	1.9 (1.9–2.0), 2	

For statement 1: AARC, $N = 401$; for ASPAN, $N = 834$; for AMSN, $N = 301$; for AACN, $N = 107$. Aggregated $N = 1,643$.
For statement 2: AARC, $N = 398$; for ASPAN, $N = 834$; for AMSN, $N = 300$; for AACN, $N = 107$. Aggregated $N = 1,639$.
IS = incentive spirometry
AARC = American Association for Respiratory Care
ASPAN = American Society of Peri-Anesthesia Nurses
AMSN = Academy of Medical-Surgical Nurses
AACN = American Association of Critical-Care Nurses

Table 4. Effectiveness in Reducing Atelectasis and Pneumonia

	Agreement	Response Options (Score)	AARC, *n* (%)	ASPAN, *n* (%)	AMSN, *n* (%)	AACN, *n* (%)	Aggregated *n* (%)	
IS helps to prevent atelectasis	Agree	Strongly agree (1)	157 (38.9)	468 (55.9)	176 (58.3)	59 (55.7)	860 (52.1)	1,593 (96.6)
		Agree (2)	147 (36.4)	296 (35.3)	106 (35.1)	2.4 (36.8)	588 (35.6)	
		Somewhat agree (3)	56 (13.9)	62 (7.4)	20 (6.6)	7 (6.6)	145 (8.8)	
	Disagree	Somewhat disagree (4)	18 (4.5)	5 (0.6)	0 (0)	0 (0)	23 (1.4)	57 (3.5)
		Disagree (5)	15 (3.7)	4 (0.5)	0 (0)	0 (0)	19 (1.2)	
		Strongly disagree (6)	11 (2.7)	3 (0.4)	0 (0)	1 (0.9)	15 (0.9)	
	Mean (95% CI), median		2.1 (2.0–2.2), 2	1.6 (1.5–1.6), 1	1.5 (1.4–1.6), 1	1.5 (1.4–1.7), 1	1.7 (1.6–1.7), 1	
IS helps to reverse atelectasis	Agree	Strongly agree (1)	95 (23.4)	311 (37.5)	105 (35.0)	40 (38.1)	551 (33.6)	1,477 (90)
		Agree (2)	144 (35.4)	301 (36.3)	113 (37.7)	38 (36.2)	596 (36.3)	
		Somewhat agree (3)	90 (22.2)	160 (19.3)	62 (20.7)	18 (17.1)	330 (20.1)	
	Disagree	Somewhat disagree (4)	37 (9.1)	42 (5.1)	10 (3.3)	5 (4.8)	94 (5.7)	164 (10)
		Disagree (5)	19 (4.7)	16 (1.9)	7 (2.3)	3 (2.9)	45 (2.7)	
		Strongly disagree (6)	21 (5.2)	0 (0)	3 (1.0)	1 (1.0)	25 (1.5)	
	Mean (95% CI), median		2.5 (2.4–2.6), 2	2.0 (1.9–2.0), 2	2.0 (1.9–2.1), 2	2.0 (1.8–2.2), 2	2.1 (2.1–2.2), 2	
IS helps to prevent pneumonia	Agree	Strongly agree (1)	86 (21.1)	396 (47.7)	156 (51.7)	50 (47.2)	688 (41.8)	1,522 (92.5)
		Agree (2)	127 (31.2)	327 (39.4)	108 (35.8)	41 (38.7)	603 (36.6)	
		Somewhat agree (3)	100 (24.6)	90 (10.8)	30 (9.9)	11 (10.4)	231 (14.0)	
	Disagree	Somewhat disagree (4)	43 (10.6)	12 (1.4)	3 (1.0)	2 (1.9)	60 (3.7)	124 (7.5)
		Disagree (5)	30 (7.4)	5 (0.6)	4 (1.3)	1 (0.9)	40 (2.4)	
		Strongly disagree (6)	21 (5.2)	1 (0.1)	1 (0.3)	1 (0.9)	240 (1.5)	
	Mean (95% CI), median		2.7 (2.6–2.8), 2	1.7 (1.6–1.7), 2	1.7 (1.6–1.7), 1	1.7 (1.6–1.9), 2	1.9 (1.9–2.0), 2	
IS helps to reverse pneumonia	Agree	Strongly agree (1)	33 (8.2)	156 (18.2)	59 (19.8)	19 (18.1)	267 (16.4)	1117 (68.4)
		Agree (2)	62 (15.4)	208 (25.2)	71 (23.8)	28 (26.7)	369 (22.6)	
		Somewhat agree (3)	97 (24.1)	255 (30.8)	105 (35.2)	24 (22.9)	481 (29.5)	
	Disagree	Somewhat disagree (4)	82 (20.4)	126 (15.2)	36 (12.1)	22 (21.0)	266 (16.3)	515 (31.6)
		Disagree (5)	77 (19.2)	73 (8.8)	23 (7.7)	9 (8.6)	182 (11.2)	
		Strongly disagree (6)	51 (12.7)	9 (1.1)	4 (1.3)	3 (2.9)	67 (4.1)	
	Mean (95% CI), median		3.6 (3.5–3.8), 4	2.7 (2.7–2.8), 3	2.7 (2.6–2.8), 3	2.8 (2.6–3.0), 3	3.0 (2.9–3.0), 3	

For statement 1: AARC, $N = 404$; for ASPAN, $N = 838$; for AMSN, $N = 302$; for AACN, $N = 106$. Aggregated $N = 1,650$.
For statement 2: AARC, $N = 406$; for ASPAN, $N = 830$; for AMSN, $N = 300$; for AACN, $N = 105$. Aggregated $N = 1,641$.
For statement 3: AARC, $N = 407$; for ASPAN, $N = 832$; for AMSN, $N = 302$; for AACN, $N = 102$. Aggregated $N = 1,646$.
For statement 4: AARC, $N = 402$; for ASPAN, $N = 827$; for AMSN, $N = 298$; for AACN, $N = 105$. Aggregated $N = 1,632$.
IS = incentive spirometry
AARC = American Association for Respiratory Care
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AMSN = Academy of Medical-Surgical Nurses
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Table 5. Effectiveness of IS Compared to Other Therapies

	Agreement	Response Options (Score)	AARC, *n* (%)	ASPAN, *n* (%)	AMSN, *n* (%)	AACN, *n* (%)	Aggregated *n* (%)	
In general, IS is as effective as early ambulation	Agree	Strongly agree (1)	59 (14.5)	181 (21.8)	70 (23.4)	17 (16.0)	327 (19.9)	1214 (74.0)
		Agree (2)	92 (22.7)	262 (31.6)	85 (28.4)	26 (24.5)	465 (28.3)	
		Somewhat agree (3)	94 (23.2)	214 (25.8)	85 (28.4)	29 (27.4)	422 (25.7)	
	Disagree	Somewhat disagree (4)	59 (14.5)	124 (14.9)	38 (12.7)	20 (18.9)	241 (14.7)	427 (26.0)
		Disagree (5)	59 (14.5)	45 (5.4)	16 (5.4)	11 (10.4)	131 (8.0)	
		Strongly disagree (6)	43 (10.6)	4 (0.5)	5 (1.7)	3 (2.8)	55 (3.4)	
	Mean (95% CI), median		3.2 (3.1–33.), 3	2.5 (2.5–2.6), 2	2.5 (2.4–2.7), 2	2.9 (2.7–3.1), 3	2.7 (2.7–2.8), 3	
In general, IS is as effective as deep breathing exercises	Agree	Strongly agree (1)	107 (26.4)	274 (32.7)	113 (37.7)	29 (27.4)	523 (3.17)	1,456 (88.2)
		Agree (2)	142 (35.0)	302 (36.0)	115 (38.3)	35 (33.0)	594 (36.0)	
		Somewhat agree (3)	88 (21.7)	178 (21.2)	48 (16.0)	25 (23.6)	33 (20.6)	
	Disagree	Somewhat disagree (4)	33 (8.1)	57 (6.8)	21 (7.0)	13 (12.3)	124 (7.5)	194 (11.8)
		Disagree (5)	20 (4.9)	22 (2.6)	3 (1.0)	3 (2.8)	48 (2.9)	
		Strongly disagree (6)	16 (3.9)	5 (0.6)	0 (0)	1 (0.9)	22 (1.3)	
	Mean (95% CI), median		2.4 (2.3–2.5), 2	2.1 (2.1–2.2), 2	2.0 (1.9–2.1), 2	2.3 (2.2–2.5), 2	2.2 (2.1–2.2), 2	
In general, IS is as effective as directed coughing	Agree	Strongly agree (1)	58 (14.3)	183 (22.1)	77 (25.8)	19 (17.9)	337 (20.6)	1,308 (79.8)
		Agree (2)	102 (25.2)	263 (31.7)	115 (38.5)	37 (34.9)	517 (31.5)	
		Somewhat agree (3)	112 (27.7)	247 (29.8)	74 (24.8)	21 (19.8)	454 (27.7)	
	Disagree	Somewhat disagree (4)	67 (16.5)	99 (11.9)	28 (9.4)	24 (22.6)	218 (13.3)	332 (20.2)
		Disagree (5)	44 (10.9)	33 (4.0)	4 (1.3)	3 (2.8)	84 (5.1)	
		Strongly disagree (6)	22 (5.4)	5 (0.6)	1 (0.3)	2 (1.9)	30 (1.8)	
	Mean (95% CI), median		3.0 (2.9–3.1), 3	2.5 (2.4–2.5), 2	2.2 (2.1–2.3), 2	2.6 (2.4–2.8), 2	2.6 (2.5–2.6), 2	

For statement 1: AARC, $N = 406$; for ASPAN, $N = 830$; for AMSN, $N = 299$; for AACN, $N = 106$. Aggregated $N = 1,641$.
For statement 2: AARC, $N = 406$; for ASPAN, $N = 838$; for AMSN, $N = 300$; for AACN, $N = 106$. Aggregated $N = 1,650$.
For statement 3: AARC, $N = 405$; for ASPAN, $N = 830$; for AMSN, $N = 299$; for AACN, $N = 106$. Aggregated $N = 1,640$.
IS = incentive spirometry
AARC = American Association for Respiratory Care
ASPAN = American Society of Peri-Anesthesia Nurses
AMSN = Academy of Medical-Surgical Nurses
AACN = American Association of Critical-Care Nurses

Table 6. When IS Should be Used

	Agreement	Response Options (Score)	AARC, *n* (%)	ASPAN, *n* (%)	AMSN, *n* (%)	AACN, *n* (%)	Aggregated *n* (%)	
IS should be used routinely preoperatively	Agree	Strongly agree (1)	75 (18.5)	216 (26.0)	88 (29.5)	35 (33.3)	414 (25.2)	1,281 (78.1)
		Agree (2)	91 (22.5)	207 (24.9)	106 (35.6)	29 (27.6)	433 (26.4)	
		Somewhat agree (3)	91 (22.5)	245 (29.5)	67 (22.5)	31 (29.5)	434 (26.5)	
	Disagree	Somewhat disagree (4)	54 (13.3)	87 (10.5)	20 (6.7)	7 (6.7)	168 (10.2)	359 (21.9)
		Disagree (5)	55 (13.6)	69 (8.3)	15 (5.0)	2 (1.9)	141 (8.6)	
		Strongly disagree (6)	39 (9.6)	8 (1.0)	2 (0.7)	1 (1.0)	50 (3.1)	
	Mean (95% CI), median		3.1 (3.0–3.2), 3	2.5 (2.5–2.6), 2	2.2 (2.1–2.4), 2	2.2 (2.0–2.4), 2	2.6 (2.5–2.6), 2	
IS should be used routinely postoperatively	Agree	Strongly agree (1)	153 (37.7)	388 (46.3)	207 (69.0)	68 (63.6)	816 (49.4)	1,504 (91.1)
		Agree (2)	114 (28.1)	251 (30.0)	78 (26.0)	29 (27.1)	472 (28.6)	
		Somewhat agree (3)	57 (14.0)	140 (16.7)	10 (3.3)	9 (8.4)	216 (13.1)	
	Disagree	Somewhat disagree (4)	20 (4.9)	26 (3.1)	2 (0.7)	0 (0)	48 (2.9)	147 (8.9)
		Disagree (5)	33 (8.1)	28 (3.3)	2 (0.7)	0 (0)	63 (3.8)	
		Strongly disagree (6)	29 (7.1)	5 (0.6)	1 (0.3)	1 (0.9)	36 (2.2)	
	Mean (95% CI), median		2.4 (2.3–2.5), 2	1.9 (1.8–1.9), 1	1.4 (1.3–1.5), 1	1.5 (1.4–1.6), 1	1.9 (1.9–1.9), 2	

For statement 1: AARC, $N = 405$; for ASPAN, $N = 832$; for AMSN, $N = 298$; for AACN, $N = 105$. Aggregated $N = 1,640$.
For statement 2: AARC, $N = 406$; for ASPAN, $N = 838$; for AMSN, $N = 300$; for AACN, $N = 107$. Aggregated $N = 1,651$.
IS = incentive spirometry
AARC = American Association for Respiratory Care
ASPAN = American Society of Peri-Anesthesia Nurses
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Table 7. IS Procedure

	Response Options	AARC, *n* (%)	ASPAN, *n* (%)	AMSN, *n* (%)	AACN, *n* (%)	Aggregated *n* (%)
Ideally, how frequently should a patient use his or her IS device?	Every 30 min	27 (6.9)	165 (20.3)	43 (14.5)	17 (16.0)	252 (15.7)
	Every 60 min	201 (51.5)	487 (59.8)	205 (69.3)	68 (64.2)	961 (59.8)
	Every 90 min	2 (0.5)	9 (1.1)	3 (1.0)	1 (0.9)	15 (0.9)
	Every 2 h (120 min)	119 (30.5)	132 (16.2)	43 (14.5)	17 (16.0)	311 (19.4)
	Every 2.5 h (150 min)	1 (0.3)	1 (0.1)	0 (0)	0 (0)	2 (0.1)
	Every 3 h (180 min)	6 (1.5)	8 (1.0)	0 (0)	2 (1.9)	16 (1.0)
	Every 3.5 h (210 min)	1 (0.3)	0 (0)	0 (0)	0 (0)	1 (0.1)
	Every 4 h (240 min)	22 (5.6)	9 (1.1)	2 (0.7)	1 (0.9)	34 (2.1)
	Every 4.5 h (270 min)	1 (0.3)	0 (0)	0 (0)	0 (0)	1 (0.1)
	Every 6 h (360 min)	3 (0.8)	1 (0.1)	0 (0)	0 (0)	4 (0.3)
	Less frequently than every 6 h (390 min)	7 (1.8)	2 (0.3)	0 (0)	0 (0)	9 (0.6)
	Mean (95% CI), median	97.8 (91.0–104.5), 60	68.4 (65.7–71.2), 60	65.9 (62.6–69.2), 60	69.1 (62.4–75.8), 60	75.1 (72.8–77.5), 60
Ideally, how many breaths should a patient take per session (*n*)?	Mean (95% CI), median	11.0 (10.6–11.5), 10	9.1 (8.7–9.5), 10	9.4 (8.7–10.2), 10	8.8 (8.2–9.4), 10	9.6 (9.3–9.9), 10
What is the ideal breath hold duration (s)?	Mean (95% CI), median	5.7 (5.3–6.1), 5	8.4 (7.8–9.0), 5	8.6 (7.6–9.6), 5	8.9 (6.6–11.1), 5	7.8 (7.4–8.2), 5
What is the initial target inspiratory volume (mL)?	Mean (95% CI), median	1,264.4 (1,197.5–1,331.2), 1,000	1,313.8 (1,263.1–1,364.6), 1,200	1,321.0 (1,243.9–1,398.1), 1,500	1,096.2 (971.0–1,221.4), 1,000	1,288.5 (1,253.8–1,323.2), 1,150
What is the ideal daily improvement in inspiratory volume (mL)?	Mean (95% CI), median	438.3 (375.5–501.1), 250	578.0 (523.5–632.6), 250	558.1 (472.9–643.3), 325	354.8 (275.2–434.4), 250	525.6 (489.8–561.4), 250
Which is the most important factor for successful IS use?	Achieving target inspiratory flow	97 (24.4)	153 (18.7)	81 (27.2)	26 (24.3)	357 (22.0)
	Achieving target inspiratory volume	138 (34.7)	480 (58.7)	158 (53.0)	53 (49.5)	829 (51.1)
	Breath hold	163 (41.0)	185 (22.6)	59 (19.8)	28 (26.2)	435 (26.8)
What is the target inspiratory flow?	As slowly as possible	80 (20.0)	196 (23.9)	73 (24.7)	25 (23.4)	374 (23.0)
	As quickly as possible	5 (1.3)	12 (1.5)	2 (0.7)	2 (1.9)	21 (1.3)
	Piston hovers in the target range (ie, in the "smiley-face" zone)	304 (75.8)	577 (70.5)	216 (73.0)	79 (73.8)	1176 (72.5)
	Not incredibly important	12 (3.0)	34 (4.2)	5 (1.7)	1 (0.9)	52 (3.2)

For question 1: AARC, $N = 390$; for ASPAN, $N = 814$; for AMSN, $N = 296$; for AACN, $N = 106$. Aggregated $N = 1,606$.
For question 2: AARC, $N = 395$; for ASPAN, $N = 824$; for AMSN, $N = 295$; for AACN, $N = 105$. Aggregated $N = 1,619$.
For question 3: AARC, $N = 395$; for ASPAN, $N = 799$; for AMSN, $N = 286$; for AACN, $N = 104$. Aggregated $N = 1,584$.
For question 4: AARC, $N = 348$; for ASPAN, $N = 769$; for AMSN, $N = 275$; for AACN, $N = 104$. Aggregated $N = 1,496$.
For question 5: AARC, $N = 334$; for ASPAN, $N = 720$; for AMSN, $N = 256$; for AACN, $N = 99$. Aggregated $N = 1,409$.
For question 6: AARC, $N = 398$; for ASPAN, $N = 818$; for AMSN, $N = 298$; for AACN, $N = 107$. Aggregated $N = 1,621$.
For question 7: AARC, $N = 401$; for ASPAN, $N = 819$; for AMSN, $N = 296$; for AACN, $N = 107$. Aggregated $N = 1,623$.
IS = incentive spirometry
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Table 8. Healthcare Professional IS Education and Training

	Agreement	Response Options (Score)	AARC, *n* (%)	ASPAN, *n* (%)	AMSN, *n* (%)	AACN, *n* (%)	Aggregated *n* (%)	
My education and training regarding IS was adequate	Agree	Strongly agree (1)	184 (45.4)	224 (26.9)	97 (32.4)	24 (22.4)	529 (32.2)	1,474 (89.6)
		Agree (2)	148 (36.5)	339 (40.7)	110 (36.8)	41 (38.3)	638 (38.8)	
		Somewhat agree (3)	51 (12.6)	172 (20.6)	55 (18.4)	29 (27.1)	307 (18.7)	
	Disagree	Somewhat disagree (4)	14 (3.5)	75 (9.0)	23 (7.7)	8 (7.5)	120 (7.3)	171 (10.4)
		Disagree (5)	7 (1.7)	20 (2.4)	13 (4.4)	3 (2.8)	43 (2.6)	
		Strongly disagree (6)	1 (0.3)	4 (0.5)	1 (0.3)	2 (1.9)	8 (0.5)	
	Mean (95% CI), median		1.8 (1.7–1.9), 2	2.2 (2.1–2.3), 2	2.2 (2.1–2.3), 2	2.4 (2.2–2.6), 2	2.1 (2.1–2.2), 2	

For AARC, $N = 405$; for ASPAN, $N = 834$; for AMSN, $N = 299$; for AACN, $N = 107$. Aggregated $N = 1{,}645$.
IS = incentive spirometry
AARC = American Association for Respiratory Care
ASPAN = American Society of Peri-Anesthesia Nurses
AMSN = Academy of Medical-Surgical Nurses
AACN = American Association of Critical-Care Nurses

- IS should be used routinely postoperatively ($P < .001$).
- In general, IS is as effective as early ambulation ($P < .05$).
- In general, IS is as effective as deep-breathing exercises ($P < .001$), except AACN versus AARC were not different, $P > .99$.
- In general, IS is as effective as directed coughing ($P < .001$).
- My education and training regarding IS was adequate ($P < .001$).

Discussion

This investigation represents a large national survey of health care professionals' perspectives on IS effectiveness and use. Despite a dearth of supportive clinical evidence,[22,28,32-35] most health care professionals believed that IS is essential to patient care, improves clinical outcomes, and is as effective as other postoperative respiratory therapies. Furthermore, despite the paucity of substantiating evidence, health care professionals collectively had strong opinions regarding use procedures with respect to frequency of use, number of breaths per session, breath-hold duration, and initial target inspiratory volumes and flow. Nevertheless, nearly all respondents believed they received adequate IS education and training.

IS has been clinically compared to other postoperative respiratory therapies. Although 2 studies found beneficial effects of IS on postoperative pulmonary complications compared to intermittent positive-pressure breathing[39]—which has been proven ineffective[55]—and physiotherapy[37] for upper abdominal surgery patients, most show no differences[11,12,26,44,47,48,56] or inferior effects (vs intermittent positive-pressure breathing[14] and CPAP[50]). In 1 investigation, IS appeared to facilitate faster tidal volume recovery to preoperative baseline versus conventional physical therapy,[57] whereas most other studies have demonstrated no advantages[11,12,26,46,47,56] or inferior[40] pulmonary function improvement compared to other respiratory therapies. Past investigations have also reported no difference between IS and other respiratory techniques in reducing postoperative pulmonary complications[6,24,40,43,52,53,58-60] or improving pulmonary function in cardiothoracic surgical patients.[24,45,52,53,60]

Further clinical research is required to determine optimal IS protocols. Previous investigators have recommended that IS usage occur hourly,[26,36,37] every 2 h,[8,38-40] 2 times per day,[41,42] 4 times per day,[14,43,44] 5 times per day,[45] 12 times per day,[11] every 4 h,[46] 4 times per hour,[47] 3 times per hour,[48] 10 times per hour,[49] 30 times per hour,[50] or every 10 min.[51] Past studies set subjects' target inspiratory volume at 50–70% of preoperative vital capacity,[14] 1,400–

1,770 mL,[44] at 200–2,000 mL,[40] or at maximal inspiration above residual volume.[43] Subjects have been instructed to complete 3 breaths per session,[42] 3–5 breaths per session,[49,52] 5 breaths per session,[53] 10 breaths per session,[8,14,26,36,37,43,45] 15 breaths per session,[46] and 20 breaths per session.[38]

Outside AARC guidelines[5] of 5-s breath holds, previous studies have used 3 s[14,40,42,44,48] or have suggested holding the breath for as long as possible.[12,26] Previous methodologies have called for IS usage at various times after surgery, including during the first 3 d after surgery,[11] starting 4–72 h after surgery,[40] both preoperatively and during the first 5 d after surgery,[37] for 5 d after surgery,[39] through postoperative day 3,[44] for postoperative days 1–4,[47] starting 1 h after surgery for 3 d,[50] and starting 4 h after extubation.[43] Certain studies report changing their use procedure during the hospital course, including increasing inspiratory target volume,[14,40] increasing both volume and breath-hold duration,[11] and decreasing frequency.[42]

Data from this investigation were consistent with the disparate IS protocols reported in the literature. Most health care professionals did report that they received adequate IS training and education, so the discrepancy likely reflects the lack of evidence-based standard protocols and presents an opportunity for further research. Guidelines may be developed for individual practice settings and patient subgroups as well. Furthermore, results from this investigation suggest that a majority of health care professionals agreed with many of the statements; however, for a low-risk intervention, the variability in the level of agreement may indicate that health care professionals recognize the dearth of evidence. High levels of agreement may indicate clinical observations that precede substantiation by clinical studies or widely disseminated myths—both explanations serve as a call for well-designed studies. With respondents indicating that they received adequate education on IS, the question of non-evidence-based material being taught is raised. If health care professionals' practice is consistent with what they learned in training, then school or clinical training offers an opportunity to introduce and integrate evidence-based care into future practice.

Comparing the results from this study to health care professionals' perspectives on other low-risk interventions may offer insight into the extent to which health care professionals are aware of the paucity of evidence and highlight the need for further investigation. Further investigation into differences among health care professional groups (eg, professional organization, position, degree, years of experience, practice location, types of patients) may provide additional important insight into the development of health care professionals' perspectives. Comparing the different types of available IS devices could be another interesting avenue of investigation.

The health care professionals' strong opinions about the effectiveness of IS despite the lack of supporting data also serves as an interesting case study in translating evidence into practice. Despite the absence of such granular data, why certain responses on the utility of IS (eg, helps to prevent atelectasis) had greater agreement than other utility statements may shed light on differences in health care professionals' practices and protocols. Practice should not be driven by opinion, but by evidence. Therefore, further investigation is needed to assess where such beliefs originate—education, training, or experience.

This investigation has several potential limitations. Health care professionals from only 4 respiratory therapy and nursing societies were sampled. We do not know the exact response rate from those who were sampled, although our survey completion rate was very high (83.8%). This may create a sampling bias where being a member of a given society predisposes respondents to certain perspectives on IS. Ideally, survey responses would be collected from all nurses and respiratory therapists across the country. The data suggest respondents believe in the use of IS in their clinical contexts. This could be due to a survey bias, a lack of understanding of the evidence, or respondents' own clinical experience.

Additional well-designed randomized clinical trials are needed to evaluate IS methods for improvement. Only then can a real determination of whether IS use improves clinical outcomes occur. Further study is needed to determine which specific patient groups may benefit from IS, the costs of implementing IS, and optimal IS use protocols.

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