Supplementary

Appendix 1

Survey (English version)

(I) Demographic characteristics

1. Name
2. Gender
3. Age (year)
4. Occupation
5. Duration of working
6. The highest degree
7. Job ranking

Basic information of department

8. The province and region where you work in
9. The full name of the hospital you are in
10. The level of the hospital you are in
11. The department you currently /mainly work in
12. Number of beds in the ICU where you work in
13. Whether airway clearance techniques (ACT)are used in your current ICU

(II) Overview of ACT clinical application

1. Whether ACT is completed at night in the ICU you are currently in
2. Whether ACT is completed on weekends and holidays in the ICU you are currently in
3. What timing do you think of using ACT
4. What indicators do you consider while using ACT preventively
5. What indicators do you consider while using ACT therapeutically
6. How frequently do you use the following treatment techniques at your workplace

Always Often Sometimes Rarely Never

i. Mucolytics
ii. Nebulized expectorants
iii. Nebulized hypertonic saline
iv. Enhanced warming and humidification
v. Instillation of saline into the airway for stimulation
vi. Early mobilization
vii. Postural drainage
viii. Manual percussion
ix. Percussion therapy device
x. High frequency chest wall oscillation
xi. Intrapulmonary percussion ventilation
xii. Continuous high frequency oscillation therapy
xiii. Mechanical insufflation-exsufflation
xiv. Incentive spirometer
xv. Non-gravity O-PEPs
xvi. Gravity O-PEPs
xvii. RC cornet
xviii. Abdominal breathing exercises
xix. Manual hyperinflation
xx. Mechanical hyperinflation

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xxi. Manual compression
xxii. Directed cough
xxiii. FET
xxiv. ACBT
xxv. Autogenic drainage
xxvi. Pharyngeal stimulation
xxvii. Blind suctioning via nasal or oral route
xxviii. Suctioning via artificial airway
xxix. Bronchoscopy
xxx. Bronchoalveolar lavage

7. How long do you use auxiliary sputum removal equipment and exercise tools in a single day
8. Which indicators or test results do you consider to evaluate the effects of ACT
9. How frequently do you encounter the following during ACT
   Always Often Sometimes Rarely Never
   i. Changes in heart rate
   ii. Cardiac arrhythmia
   iii. Changes in blood pressure
   iv. Changes of SpO2
   v. Changes of respiratory rate
   vi. Increased pain
10. How does the ACT charge

(III) Experience with specific ACT devices

1. Do you use percussion therapy device at your workplace
2. Percussion therapy device
   i. Which treatment frequency in patients receiving percussion therapy device do you usually choose
   ii. Which oscillation frequency do you usually choose
   iii. How long does a single treatment usually spend
   iv. Patient tolerance to percussion therapy device
   v. What do you think of the effect of percussion therapy device
3. Do you use high frequency chest wall oscillation (HFCWO) at your workplace
4. HFCWO
   i. Which treatment frequency in patients receiving HFCWO
   ii. Which treatment intensity do you usually choose
   iii. Which oscillation frequency do you usually choose
   iv. How long does a single treatment usually spend
   v. Patient tolerance to high frequency chest wall oscillation
   vi. What do you think of the effect of HFCWO
5. Do you use CHFO at your workplace
6. CHFO
   i. Which treatment frequency in patients receiving CHFO do you usually choose
   ii. Which gas flow do you usually choose
   iii. Which oscillation frequency do you usually choose
   iv. How long does a single treatment usually spend
   v. Patient tolerance to CHFO
   vi. What do you think of the effect of CHFO
7. Do you use mechanical insufflation-exsufflation (MI-E) at your workplace
8. MI-E

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i. Which treatment frequency in patients receiving MI-E do you usually choose
ii. Whether to open the Cough-Trak function priorly
iii. Which positive pressure do you usually choose
iv. Which negative pressure do you usually choose
v. Patient tolerance to MI-E
vi. What do you think of the effect of MI-E

9. What do you consider when setting protocols and parameters of ACT

(IV) Challenges and suggestions for improvement

1. What problems do you think there are with ACT in clinical applications
2. Which aspects do you think ACT needs to be improved in clinical applications
3. If you are invited to participate in relevant training, your expected duration of training would be
4. If you are invited to participate in relevant training, your expected training forms would be
5. Please leave your contact if you would

Abbreviations:

ACBT, active cycle breathing technology; ACT, airway clearance technique; AD, autogenic drainage; CHFO, continuous high frequency oscillation therapy; DC, directed cough; FET, forced expiratory technology; HFCWO, high frequency chest wall oscillation; ICU, intensive care unit; IPV, intrapulmonary percussion ventilation;IS, incentive spirometer; MI-E, mechanical insufflation-exsufflation; PEP, positive expiratory pressure.

(Thanks for your support and participation!)

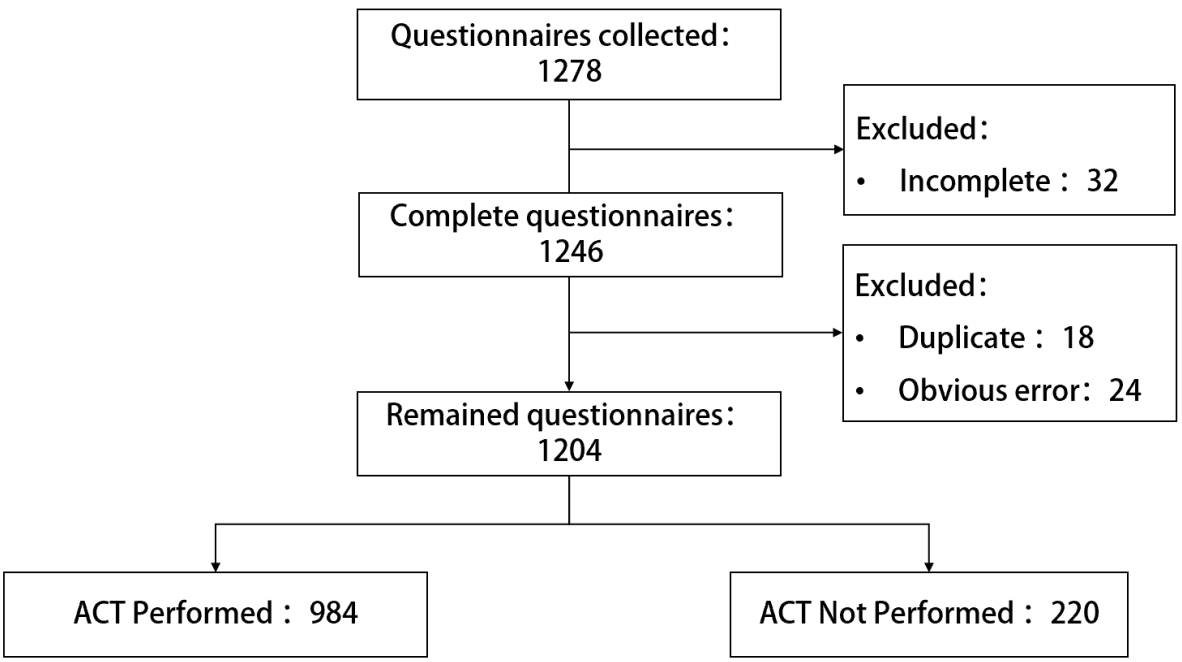

Figure S1 Questionnaire Screening and ACT Performance Flowchart. ACT, airway clearance technique.

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Table S1 Overview of ACT implementation

Questions	N=984
ACT implementation, n (%)	
At night	591(60.1)
On weekends	772(78.5)
Role in implementation of ACT	
Leading	579(58.8)
Participating	405(41.2)
Timing of use, n (%)	
Preventive	32(3.3)
Therapeutic	169(17.2)
Both	783(79.6)
Total duration of treatment in a single day, n (%)	
<30min	325(33.0)
30~60min	537(54.6)
>60min	122(12.4)
Relevant fee items, n (%)	
None	210(21.3)
Partially	735(74.7)
All	39(4.0)

ACT, airway clearance technique.

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Table S2 Subgroup analysis of ACT implementation: GICU vs Others

Frequency	Total (n=984)					GICU (n=460)					p
	Always	Often	Sometimes	Rarely	Never	Always	Often	Sometimes	Rarely	Never	
Mucolytics	408(41.5)	340(34.6)	159(16.2)	69(7.0)	8(0.8)	185(40.2)	167(36.6)	74(16.1)	32(7.0)	2(0.4)	0.761
Nebulized expectorants	549(55.8)	361(36.7)	64(6.5)	8(0.8)	2(0.2)	254(55.2)	177(38.5)	25(5.4)	3(0.7)	1(0.2)	0.998
Nebulized hypertonic saline	61(6.2)	74(7.5)	197(20.0)	332(33.7)	320(32.5)	32(7.0)	30(6.5)	87(18.9)	147(32.0)	164(35.7)	0.143
Enhanced warming and humidification	653(66.4)	255(25.9)	62(6.3)	12(1.2)	2(0.2)	323(70.2)	114(24.8)	19(4.1)	3(0.7)	1(0.2)	0.006
Instillation of saline into the airway for stimulation	46(4.7)	71(7.2)	191(19.4)	331(33.6)	345(35.1)	20(4.4)	37(8.0)	80(17.4)	161(35.0)	162(35.2)	0.663
Early mobilization	351(35.8)	323(32.8)	198(20.1)	93(9.5)	18(1.8)	160(34.8)	156(33.9)	95(20.6)	43(9.4)	6(1.3)	0.866
Postural drainage	499(50.7)	333(33.8)	123(12.5)	28(2.9)	1(0.1)	248(53.9)	144(31.3)	59(12.8)	9(2.0)	0(0)	0.077
Manual percussion	491(49.9)	340(34.6)	118(12.0)	28(2.9)	7(0.7)	234(50.9)	159(34.6)	50(10.9)	13(2.8)	4(0.9)	0.485
Percussion therapy device	420(42.7)	319(32.4)	119(12.1)	64(6.5)	62(6.3)	214(46.5)	152(33.0)	46(10.0)	23(5.0)	25(5.4)	0.003
HFCWO	238(24.2)	252(25.6)	123(12.5)	120(12.2)	251(25.5)	104(22.6)	118(25.7)	53(11.5)	49(10.7)	136(29.6)	0.066
IPV	78(7.9)	81(8.2)	136(13.8)	189(19.2)	500(50.8)	43(9.4)	31(6.7)	54(11.7)	82(17.8)	250(54.4)	0.103
CHFO	58(5.9)	71(7.2)	131(13.3)	192(19.5)	532(54.1)	30(6.5)	40(8.7)	53(11.5)	71(15.4)	266(57.8)	0.231
MI-E	88(8.9)	123(12.5)	124(12.6)	156(15.9)	493(50.1)	48(10.4)	56(12.2)	62(13.5)	62(13.5)	232(50.4)	0.594
IS	61(6.2)	100(10.2)	120(12.2)	201(20.4)	502(51.0)	27(5.9)	43(9.4)	43(9.4)	93(20.2)	254(55.2)	0.011
Non-gravity O-PEPs	54(5.5)	90(9.2)	132(13.4)	195(19.8)	513(52.1)	18(3.9)	30(6.5)	49(10.7)	93(20.2)	270(58.7)	0.549
Gravity O-PEPs	35(3.6)	57(5.8)	119(12.1)	210(21.3)	563(57.2)	18(3.9)	23(5.0)	43(9.4)	90(19.6)	286(68.6)	<0.001
RC cornet	33(3.4)	27(2.7)	103(10.5)	185(18.8)	636(64.6)	14(3.0)	11(2.4)	33(7.2)	80(17.4)	322(70.0)	0.006
Abdominal breathing exercises	233(23.7)	303(30.8)	266(27.0)	112(11.4)	70(7.1)	81(17.6)	137(19.8)	159(34.6)	60(13.0)	23(5.0)	<0.001
Manual hyperinflation	129(13.1)	198(20.2)	198(20.1)	286(29.1)	173(17.6)	60(13.0)	103(22.4)	142(30.9)	89(19.4)	66(14.3)	<0.001
Mechanical hyperinflation	287(29.2)	375(38.1)	224(22.8)	65(6.6)	33(3.4)	143(31.1)	175(38.0)	106(23.0)	23(5.0)	13(2.8)	0.098
Manual compression	125(12.7)	161(16.4)	326(33.1)	242(24.6)	130(13.2)	52(11.3)	74(16.1)	168(36.5)	112(24.3)	54(11.7)	0.869
Directed cough	306(31.1)	393(39.9)	201(20.4)	54(5.5)	30(3.1)	141(30.6)	193(42.0)	100(21.7)	19(4.1)	7(1.5)	0.417
FET	248(25.2)	250(25.4)	248(25.2)	168(17.1)	116(11.8)	81(17.6)	111(24.1)	136(29.6)	77(16.7)	55(12.0)	<0.001
ACBT	173(17.6)	201(20.4)	225(22.9)	204(20.7)	181(18.4)	72(15.6)	85(18.5)	106(23.0)	99(21.5)	98(21.3)	0.007
Autogenic drainage	203(20.6)	324(32.9)	267(27.1)	135(13.7)	55(5.6)	96(20.9)	149(32.4)	128(27.8)	56(12.2)	31(6.7)	0.954
Pharyngeal stimulation	123(12.5)	239(24.3)	357(36.3)	196(19.9)	69(7.0)	56(12.2)	133(28.9)	170(37.0)	73(15.9)	28(6.1)	0.004
Blind suctioning via nasal or oral route	285(29.0)	395(40.1)	238(24.2)	55(5.6)	11(1.1)	130(28.3)	196(42.6)	110(23.9)	18(3.9)	6(1.3)	0.562
Suctioning via artificial airway	506(51.4)	383(38.9)	76(7.7)	18(1.8)	1(0.1)	252(54.8)	182(39.6)	21(4.6)	5(1.1)	0(0)	0.005
Bronchoscopy	314(31.9)	425(43.2)	201(20.4)	33(3.6)	11(1.1)	158(34.4)	213(46.3)	83(18.0)	6(1.3)	0(0)	<0.001
Bronchoalveolar lavage	272(27.6)	364(37.0)	261(26.5)	72(7.3)	15(1.5)	130(28.3)	177(38.5)	125(27.2)	25(5.4)	3(0.6)	0.143

ACBT, active cycle of breathing technique; ACT, airway clearance technique; CHFO, continuous high-frequency oscillation therapy; FET, forced expiratory technique; GICU, general intensive care unit; HFCWO, high frequency chest wall oscillation; IPV, intrapulmonary percussion ventilation; IS, incentive spirometer; MI-E, mechanical insufflation-exsufflation; O-PEPs, oscillation positive expiratory pressure devices.

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Table S3 Challenges and recommendations for improvement

Questions	Yes (N=984)	No (N=220)	P
Problems, n (%)			
Lack of equipment/supplies, etc	855(86.9)	196(89.1)	0.439
Shortage of specialized personnel	847(86.1)	191(86.8)	0.857
Lack of awareness	844(85.8)	175(79.5)	0.027
Absence of protocols	770(78.3)	167(75.9)	0.505
Insufficient theoretical knowledge	731(74.3)	159(72.3)	0.596
No in-hospital ACT billing	715(72.7)	160(72.7)	0.999
Patient non-cooperation	578(58.7)	135(61.4)	0.522
Patient economic hardship	561(57.0)	119(54.1)	0.475
Suggestions, n (%)			
Enhancing training and awareness	900(91.5)	202(91.8)	0.971
Improving equipment access	877(89.1)	197(89.5)	0.951
Establishing protocols	869(88.3)	197(89.5)	0.688
Introducing billing items	833(84.7)	190(86.4)	0.591
Promoting ACT engagement	797(81.0)	181(82.3)	0.732
Enhancing patient education	775(78.8)	170(77.3)	0.693
Improving relevant reimbursement system	712(72.4)	169(76.8)	0.206
Standardizing documentation	674(68.5)	161(73.2)	0.2
Expected duration of training would be, n (%)			
1~2h	71(7.2)	18(8.2)	0.023
Less than half of a day	328(33.3)	55(25.0)	
About 1day	263(26.7)	59(26.8)	
About 2days	155(15.8)	32(14.5)	
Longer	167(17.0)	56(25.5)	
Expected training forms would be, n (%)			
Hands-on practice	926(94.1)	206(93.6)	0.914
Theoretical teaching	868(88.2)	193(87.7)	0.932
Video tutorials	744(75.6)	161(73.2)	0.504

ACT, airway clearance technique.

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