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## After-hours respiratory physiotherapy for intubated and mechanically ventilated patients with community-acquired pneumonia: An Australian perspective

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1 **Abstract**

2 Introduction

3 Community acquired pneumonia (CAP) is a common reason for admission to an intensive  
4 care unit for intubation and mechanical ventilation, and results in high morbidity and  
5 mortality. The primary aim of the study was to investigate availability and provision of  
6 respiratory physiotherapy, outside of normal business hours, for intubated and mechanically  
7 ventilated adults with CAP in Australian hospitals.

8 Materials and methods

9 A cross-sectional, mixed methods online survey was conducted. Participants were senior  
10 intensive care unit physiotherapists from 88 public and private hospitals. Main outcome  
11 measures included presence and nature of an after-hours physiotherapy service and factors  
12 perceived to influence the need for after-hours respiratory physiotherapy intervention, when  
13 the service was available, for intubated adult patients with CAP. Data were also collected  
14 regarding respiratory intervention provided after-hours by other ICU professionals.

15 Results

16 Response rate was 72% (n=75). An after-hours physiotherapy service was provided by n=31  
17 (46%) hospitals and onsite after-hours physiotherapy presence was limited (22%), with a  
18 combination of onsite and on-call service reported by 19%. Treatment response (83%) was  
19 the most frequent factor for referring patients with CAP for after-hours physiotherapy  
20 intervention by the treating day-time physiotherapist. Nurses performing respiratory  
21 intervention (77%) was significantly associated with no available after-hours physiotherapy  
22 service (p=0.04).

23 Discussion

24 Physiotherapy after-hours service in Australia is limited, therefore it is common for intubated  
25 patients with CAP not to receive any respiratory physiotherapy intervention outside of normal

26 business hours. In the absence of an after-hours physiotherapist, nurses were most likely to  
27 perform after-hours respiratory intervention to intubated patients with CAP.

## 28 Conclusion

29 Further research is required to determine whether the frequency of respiratory physiotherapy  
30 intervention, including after-hours provision of treatment, influences outcomes for ICU  
31 patients intubated with pneumonia.

32 **Key Words (MeSH):** Critical Care, Physical Therapy Modalities, Pneumonia, Respiration  
33 Artificial.

## 34 **Introduction**

35 Severe community acquired pneumonia (CAP) is a common cause for admission to an ICU,  
36 for intubation and mechanical ventilation due to respiratory failure and septic shock, and is  
37 associated with high levels of morbidity and mortality<sup>1,2</sup>. Lung infection and inflammation in  
38 pneumonia result in reduced compliance and alveolar ventilation<sup>3</sup>, and exudation of purulent  
39 sputum into the airways<sup>4</sup>, all of which contribute to impaired gas exchange and respiratory  
40 failure<sup>3</sup>. Physiotherapists working in ICU commonly treat intubated and mechanically  
41 ventilated patients with respiratory illness such as CAP, with the aims of facilitating airway  
42 clearance, enhancing alveolar ventilation, improving respiratory mechanics and commencing  
43 functional rehabilitation<sup>5,6</sup>. Evidence from randomised, controlled trials indicates that  
44 respiratory physiotherapy intervention involving lung hyperinflation techniques is beneficial  
45 for improving lung compliance<sup>7,8,9</sup>, airway resistance<sup>8</sup> and sputum clearance<sup>7,9</sup> in  
46 heterogeneous mechanically ventilated patients. However the proven benefits have been  
47 short lived<sup>10</sup>, with improvements in lung compliance reported to be maintained at 20 minutes<sup>7</sup>  
48 and 30 minutes<sup>8</sup> after intervention and reduction in airway resistance maintained at 20  
49 minutes following intervention<sup>8</sup>. There is minimal evidence regarding the optimal dosage of  
50 intervention duration and frequency<sup>11</sup> for specific patient cohorts mechanically ventilated with  
51 acute respiratory illness such as CAP, leaving little guidance for physiotherapists on how

52 best to contribute to optimising patient care for those admitted to ICU with CAP across  
53 Australia.

54

55 It has previously been highlighted that in Australian hospitals, limited physiotherapy services  
56 exist after-hours, including on weekends, compared with normal business hours Monday to  
57 Friday<sup>12-14</sup>. This is in contrast to health care systems in the UK, where 97% of ICUs reported  
58 to have 24-hour access to physiotherapy<sup>15</sup>, and in Canada where 97% of hospitals were  
59 reported to have a weekend physiotherapy service, although weekend physiotherapy staffing  
60 levels were 88% less than on weekdays<sup>16</sup>. In people with acute or subacute conditions, the  
61 provision of 19 minutes of extra physiotherapy per day had small, but significant, benefits in  
62 reducing hospital length of stay in both the acute and rehabilitation settings<sup>17</sup>. Functional and  
63 quality of life outcomes were also improved for a variety of patient cohorts including cardiac  
64 and orthopaedic surgery, and stroke<sup>17</sup>. The effects of respiratory physiotherapy being  
65 provided after-hours specifically in the critical care setting have been examined in a  
66 systematic review<sup>13</sup> which indicates two studies that reported results for subgroups in ICU,  
67 one for patients with acute spinal cord injury (n=14)<sup>18</sup> and another for patients following high  
68 risk upper abdominal surgery (n=31)<sup>19</sup>. Both these studies reported a significant reduction in  
69 pulmonary complications and length of stay, and when after-hours respiratory physiotherapy  
70 was provided following early extubation of patients with acute spinal cord injury this  
71 translated to a significant cost saving for the hospital<sup>18</sup>. However, to date no research has  
72 been conducted to examine provision of respiratory physiotherapy outside of normal  
73 business hours for intubated and mechanically ventilated patients with acute respiratory  
74 illness, such as CAP. The primary aim of this study was to investigate the availability and  
75 provision of after-hours respiratory physiotherapy intervention for intubated and mechanically  
76 ventilated adults with CAP throughout Australia. The secondary aims were to explore  
77 indications for referral for after-hours physiotherapy intervention for this group of patients,  
78 and how the respiratory intervention may be managed by other ICU health professionals  
79 when an after-hours physiotherapy service is limited or unavailable.

80

81 **Materials and Methods**

82 This study was nested within a larger online survey<sup>20</sup> using SurveyMonkey® (Palo Alto:  
83 USA), developed and piloted to explore current physiotherapy practice and clinical reasoning  
84 for adult intubated patients with CAP. Data collection for the primary study occurred over 6  
85 consecutive months during 2014 and 2015. Senior physiotherapists working in Level 2 or 3<sup>21</sup>  
86 metropolitan and rural Australian ICUs were targeted for recruitment to the study. Participant  
87 inclusion criteria and recruitment, methods and full survey details have been published  
88 elsewhere<sup>20</sup>. Survey participants were asked to describe their practice regarding respiratory  
89 physiotherapy intervention for intubated and mechanically ventilated patients with CAP, and  
90 the types, typical duration and frequency of intervention provided for this patient cohort  
91 based on their own clinical experience. Ten of the survey items specifically enquired about  
92 after-hours physiotherapy service delivery, providing the data for this report. These survey  
93 items used categorical scales to determine the amount and nature of an after-hours  
94 physiotherapy service available. Likert scales were used to investigate the factors which  
95 respondents felt influenced the need for after-hours respiratory physiotherapy intervention  
96 for intubated patients with CAP based on their own clinical experience. Similarly, categorical  
97 scales were used to explore respondents' perception of whether respiratory physiotherapy  
98 interventions were performed by other health professionals in the ICU outside of normal  
99 business hours, and the types of respiratory physiotherapy interventions performed by non-  
100 physiotherapy health professionals in the ICU for intubated patients with CAP after-hours,  
101 based on the opinion of respondents. Ethics approval was granted by the Human Research  
102 and Ethics Committees of The University of Notre Dame Australia (014130F), and local  
103 hospital ethics committees.

104 Quantitative data were summarised using descriptive statistics and associations were  
105 analysed using Chi-square with Fisher exact test, using SPSS version 22 (IBM SPSS  
106 Statistics, IBM Corp, New York: USA).

107

108 **Results**

109 The nested survey was sent to 104 senior physiotherapists at 88 hospitals, with global  
110 survey results published previously<sup>20</sup>. Results presented uniquely here pertain to after-hours  
111 physiotherapy only. The survey response rate was 72% (n=75) and 79% of respondents  
112 (n=54) were from public hospitals. Bed capacity of the ICU, as reported by respondents<sup>20</sup>,  
113 was 10 beds or less in 26% of respondents (n=18), 11-20 beds in 46% (n=31) and over 20  
114 beds in 28% (n=19). Sixty percent of respondents (n=41) reported between 1.0 and 2.0 full  
115 time equivalent (FTE) physiotherapy staffing, and 32% (n=22) reported between 3.0 and 4.0  
116 FTE respectively. The availability of after-hours physiotherapy is outlined in Figure 1. (Insert  
117 Figure 1 here)

118

119

120 Of the 75 physiotherapists, there were 68 participants who responded to the survey items  
121 that related to service provision. Of these respondents 97% (n = 66) indicated that a  
122 weekend ICU physiotherapy service existed during the day-time on both Saturdays and  
123 Sundays. Respondent state of jurisdiction are presented in Figure 2. (Insert Figure 2 here)

124

125 Chi-square analysis indicated that ICU bed capacity was significantly associated with  
126 weekday physiotherapy FTE staffing, as reported by respondents, with ICUs of larger bed  
127 capacity having greater reported levels of physiotherapy staffing ( $p<0.001$ ). Public facilities  
128 were also significantly associated with greater ICU physiotherapy staffing levels, over 2.0  
129 FTE ( $p=0.004$ ). Further chi-square analyses also indicated that there was a significant  
130 association between both ICU bed capacity ( $p=0.002$ ) and physiotherapy FTE ( $p=0.018$ ) with  
131 presence of an after-hours physiotherapy service, with ICUs of greater bed capacity or  
132 greater physiotherapy staffing being more likely to have an after-hours physiotherapy service  
133 available. Respondents reported that patients with CAP in ICU were significantly more likely

134 to receive more frequent respiratory physiotherapy (two or more times a day) when an after-  
135 hours physiotherapy service was available ( $p=0.018$ ).

136 There was a significant association between jurisdiction and reported presence of an after-  
137 hours physiotherapy service ( $p<0.001$ ), with after-hours physiotherapy services being more  
138 common in Queensland (QLD), New South Wales (NSW) and Western Australia (WA)  
139 compared with other Australian states.

140 Figure 3 illustrates the most frequent reasons reported for referral of intubated and  
141 mechanically ventilated patients with CAP by the treating day-time physiotherapist to the  
142 after-hours physiotherapist, when this service was available. (Insert Figure 3 here)

143 The greatest factor reported by respondents influencing the need for after-hours  
144 physiotherapy intervention was whether day time physiotherapy intervention resulted in a  
145 positive change in assessment findings. Respondents' perception of the bedside nurse's  
146 capability of managing the patient's secretions, and the volume of secretions, were also  
147 important considerations reported by the ICU physiotherapist when determining referral for  
148 after-hours physiotherapy.

149 There was a significant association between respiratory physiotherapy interventions being  
150 conducted by other (non-physiotherapy) health professionals in the ICU and an after-hour  
151 physiotherapy service not being available ( $p=0.04$ ). It was reported by 53% of respondents  
152 ( $n= 30$ ) that other health professionals within the ICU performed respiratory physiotherapy  
153 techniques after-hours, with 37% ( $n=21$ ) reporting that this occurrence was occasional only.

154 There was a significant association between respiratory physiotherapy intervention being  
155 provided by nurses (77%,  $n= 36/47$ ) and no after-hours physiotherapist availability ( $p=0.04$ ).

156 Twenty-one percent of respondents ( $n=10/47$ ) reported that in the absence of an after-hours  
157 physiotherapist, either doctors (2%) or nurses (98%) performed respiratory physiotherapy  
158 intervention if necessary. The most common respiratory techniques reportedly performed by  
159 nurses or doctors to intubated patients with CAP outside of normal business hours were:

160 endotracheal suction (92% of respondents,  $n= 43$ ), positioning (77% of respondents,  $n= 36$ ),



161 deep breathing and coughing (43% of respondents, n= 20) and administration of normal  
162 saline to the airway (40% of respondents, n=19). Figure 4 illustrates other respiratory  
163 techniques which were reported to be less commonly performed after-hours by those other  
164 than physiotherapists. (Insert Figure 4 here)

165

## 166 **Discussion**

167

168 This study is the first survey of physiotherapists regarding after-hours physiotherapy service  
169 provision within the acute hospital setting in over 20 years. However findings remain  
170 consistent with those reported previously<sup>11</sup>, in that less than half of respondents indicated an  
171 after-hours physiotherapy service was available to ICU patients and that the majority of  
172 facilities that did provide an after-hours physiotherapy service utilised an on-call system.

173 Physiotherapists are an integral and essential part of the ICU multidisciplinary team,  
174 possessing skills that contribute to optimisation and enhancement of respiratory function for  
175 critically ill patients receiving mechanical ventilation<sup>5,22</sup>, such as those with CAP. Traditionally  
176 ICUs are staffed 24 hours per day, seven days a week by doctors and nurses, however  
177 physiotherapists in acute hospitals across Australia most commonly only work during day-  
178 time hours<sup>13,11,23</sup>. This is in contrast to the College of Intensive Care Medicine of Australia  
179 and New Zealand<sup>21</sup> and the British Faculty of Intensive Care Medicine<sup>24</sup> best practice  
180 standards which recommend access to a physiotherapist 24-hours per day to provide for the  
181 needs of patients in ICU, and furthermore that “physiotherapy staffing should be adequate to  
182 provide both the respiratory and rehabilitation components of care”<sup>24</sup>.

183

184 The survey results indicate the profile of an Australian hospital with an after-hours  
185 physiotherapy service is most likely a public facility, with an ICU of greater than 20 beds,  
186 located within the states of QLD, NSW or WA. The after-hours service is most likely to be an

187 on-call service, or an onsite service for part of the evening with an on-call service available  
188 thereafter. In order to maintain anonymity of participants and facilities it was not possible to  
189 identify which ICUs were Level 3 and which were metropolitan, however the above profile  
190 does suggest that the public hospitals with large ICUs of greater than 20 beds are most likely  
191 to be tertiary or quaternary facilities, providing an after-hours physiotherapy service  
192 potentially due to a higher acuity, complexity and specialised casemix. In an Australian  
193 survey of chief physiotherapists respondents indicated that after-hours physiotherapy was  
194 provided to certain hospital specialty areas such as ICU, general medical and surgical  
195 wards, transplants and burns, as these patient groups were considered to be at high risk of  
196 deterioration as a result of respiratory complications from their medical condition with the  
197 absence of respiratory physiotherapy intervention<sup>11</sup>.

198 Lim et al<sup>25</sup> profiled the types of patients referred for after-hours physiotherapy at a tertiary  
199 hospital in Singapore. Pneumonia was one of the most common diagnoses referred to after-  
200 hours physiotherapy, with mucociliary clearance being one of the most common reasons for  
201 referral based on the clinical reasoning of the day-time physiotherapist, and 20% of referrals  
202 by medical staff having a primary diagnosis of pneumonia. However, it was not reported if  
203 the type of pneumonia was community acquired, or whether the patients were intubated and  
204 mechanically ventilated at the time of referral. A randomised controlled trial in an Australian  
205 setting found that patients with ventilator associated pneumonia and acquired brain injury  
206 receiving respiratory intervention provided by a physiotherapist six times over a 24-hour  
207 period showed a trend towards faster recovery and less occurrence of lobar collapse<sup>26</sup>, but  
208 this study was limited by small sample size (n=33). Furthermore, the specific nature of the  
209 population studied presented limitations to respiratory physiotherapy intervention, such as  
210 the need to treat in the head up position due to presence of an intraventricular drain and  
211 minimisation of stimulation to control intracranial and cerebral perfusion pressure by limiting  
212 endotracheal tube suction, which may have influenced effectiveness of physiotherapy and  
213 potential for impact on outcomes<sup>26</sup>. Therefore caution must be exercised when extrapolating  
214 these results to other ICU patient populations. Further investigation regarding the benefits

215 and frequency of physiotherapy intervention for intubated and mechanically ventilated  
216 patients with acute respiratory illness or dysfunction is required.

217

218 The most common reason reported by respondents for referring an intubated patient with  
219 CAP for after-hours respiratory physiotherapy was whether an objective benefit was  
220 demonstrated from day-time physiotherapy intervention. However, the capacity for a patient  
221 to receive respiratory physiotherapy more frequently over a 24-hour period depends on the  
222 availability of sufficient staffing, including an after-hours physiotherapy service. If no after-  
223 hours physiotherapy service is available, intubated patients with acute respiratory illness  
224 such as CAP with deteriorating respiratory function may have worse patient outcomes such  
225 as prolonged mechanical ventilation time, increased ICU and hospital length of stay, and  
226 greater mortality, however to date there are no published data to support this. Due to the  
227 pathophysiology of CAP resulting in increased sputum production<sup>4</sup> and reduced lung  
228 compliance and alveolar ventilation<sup>3</sup>, sputum retention and atelectasis can occur at any time,  
229 not only during day-time hours when an ICU physiotherapist is most likely to be available.  
230 Furthermore, common ventilator settings may cause an inspiratory flow bias resulting in  
231 caudad movement of secretions within the airways, with secretions being embedded, rather  
232 than expelled from the lungs<sup>27</sup>. The absence of regular respiratory intervention to clear  
233 sputum and re-inflate underventilated alveoli may lead to increased V/Q mismatch and  
234 shunt, and worsening of hypoxaemia<sup>3</sup>.

235

236 In the opinion of respondents, in the absence of an after-hours physiotherapist nurses were  
237 the professionals most likely to perform after-hours respiratory intervention to intubated  
238 patients with CAP. However over one third of respondents indicated that this was only  
239 occasional, implying that the majority of these patients received no respiratory intervention  
240 until the physiotherapist returned to work the following day. The respiratory intervention  
241 respondents believed to be delivered after-hours by nursing staff consisted mostly of

242 positioning, deep breathing and coughing (presumably once the patient was awake enough  
243 to participate), administration of normal saline to the airway, and endotracheal suctioning, all  
244 of which could be classified under the scope of standard nursing care, rather than solely the  
245 purview of physiotherapy. Very few respondents believed that nursing staff in their facilities  
246 performed treatment techniques which are traditionally considered “physiotherapy” such as  
247 percussion (5%), vibrations (7%), manual hyperinflation (8%) or ventilator hyperinflation  
248 (2%). In contrast, Chaboyer et al<sup>12</sup> reported a much higher use of chest percussion (55%)  
249 and vibration (56%) techniques by nursing staff but did not report any use of hyperinflation  
250 techniques. Of all the respiratory physiotherapy techniques used for intubated patients, the  
251 use of hyperinflation techniques has the highest evidence of efficacy. As discussed by  
252 Ntoumenopoulos & Greenwood<sup>11</sup> this brings into question the quality and efficacy of the  
253 respiratory treatment delivered by nursing staff after-hours. Due to time constraints, it is  
254 unlikely the ICU nursing staff have capacity to provide the same level of respiratory  
255 intervention as a physiotherapist, who has more time dedicated to the optimisation of the  
256 patient's respiratory function, as one of their primary roles<sup>11</sup>. Ntoumenopoulos and  
257 Greenwood<sup>11</sup> suggested that nursing staff may not be adequately trained to enable provision  
258 of respiratory intervention with the same level of quality and efficacy as an ICU  
259 physiotherapist, whose practice is based on a complex clinical reasoning process<sup>11, 28, 29</sup>.

260 This process integrates continuous patient assessment, an advanced understanding of  
261 respiratory mechanics and pathophysiology, indications for and contraindications against  
262 intervention modes, and the ability to adjust and modify intervention according to the  
263 individual patient's presentation, clinical need and treatment response.

264 The good response rate from experienced senior clinicians from all states in this study (72%)  
265 provides confidence that data are representative of physiotherapy service provision to level 2  
266 and 3 ICUs across Australia, thereby affording strength and robustness to the findings. The  
267 reporting of after-hours respiratory intervention provided by non-physiotherapists is based on  
268 the opinion of the respondents from a physiotherapy perspective, which may differ if ICU  
269 nursing staff were surveyed directly, and this is a limitation of the study. In addition, reported

270 physiotherapy staffing levels are based on the respondents' opinion and may not reflect  
271 actual staffing levels. This information could be enhanced by obtaining data directly from  
272 Human Resource or Physiotherapy Department managers.

273

274 This is the first study to provide a snapshot of respiratory physiotherapy intervention outside  
275 of normal business hours for intubated and mechanically ventilated patients with an acute,  
276 potentially curable, respiratory illness. The majority of Australian ICUs do not provide an  
277 after-hours physiotherapy service, despite recommendations from peak professional bodies  
278 in both Australia and the UK supporting provision of this service. The implication is that  
279 nurses are largely left with the responsibility of providing the patient's respiratory intervention  
280 outside of business hours. The facilities with an after-hours physiotherapy service are able to  
281 provide respiratory intervention to patients with CAP more frequently, basing this intervention  
282 on the patient's response to day-time physiotherapy intervention, the volume and nature of  
283 secretions present and the physiotherapists' perception of whether these secretions can be  
284 managed adequately by the bed-side nurse. Further research, in the form of multi-centred  
285 randomised and controlled trials, is necessary to determine whether after-hours respiratory  
286 physiotherapy adds benefit to both intubated patients with CAP through improved outcomes,  
287 and to health systems by reducing ICU bed days and hospital length of stay.

288

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378 **Figure Legends**

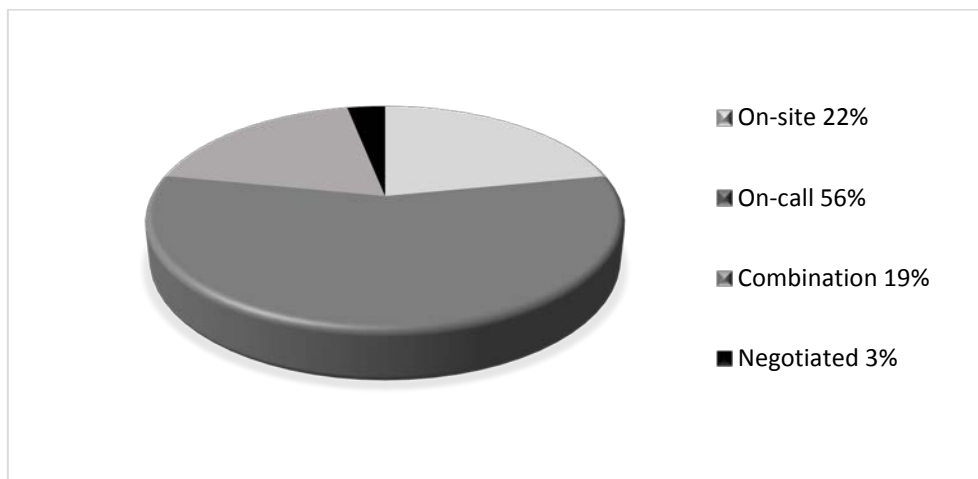
379 Figure 1: Types of after-hours physiotherapy service.

380 Figure 2: Respondent jurisdiction by state.

381 Figure 3: Factors influencing PT referral for after-hours respiratory PT.

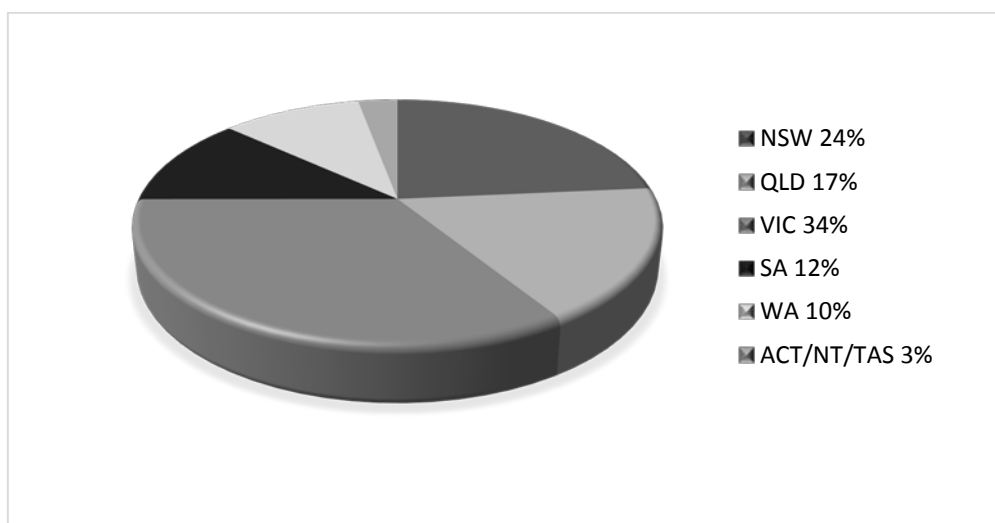
382 Figure 4: Types of after-hours respiratory interventions which physiotherapists report to be  
383 performed by other health professionals in the ICU.

384 **Figure 1**



385

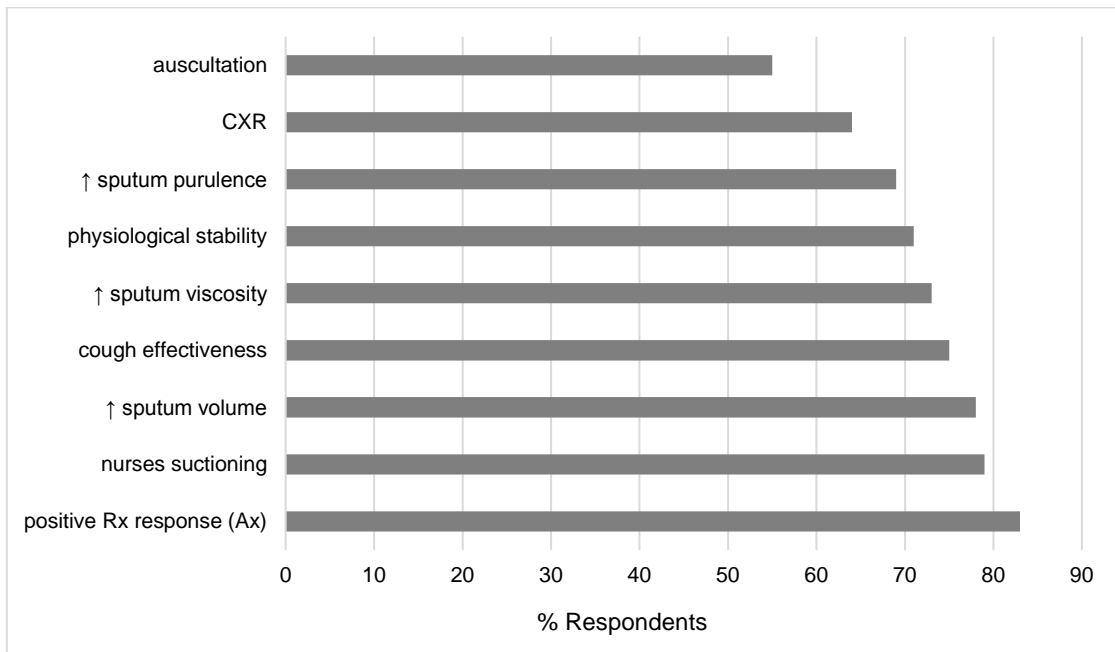
386 **Figure 2**



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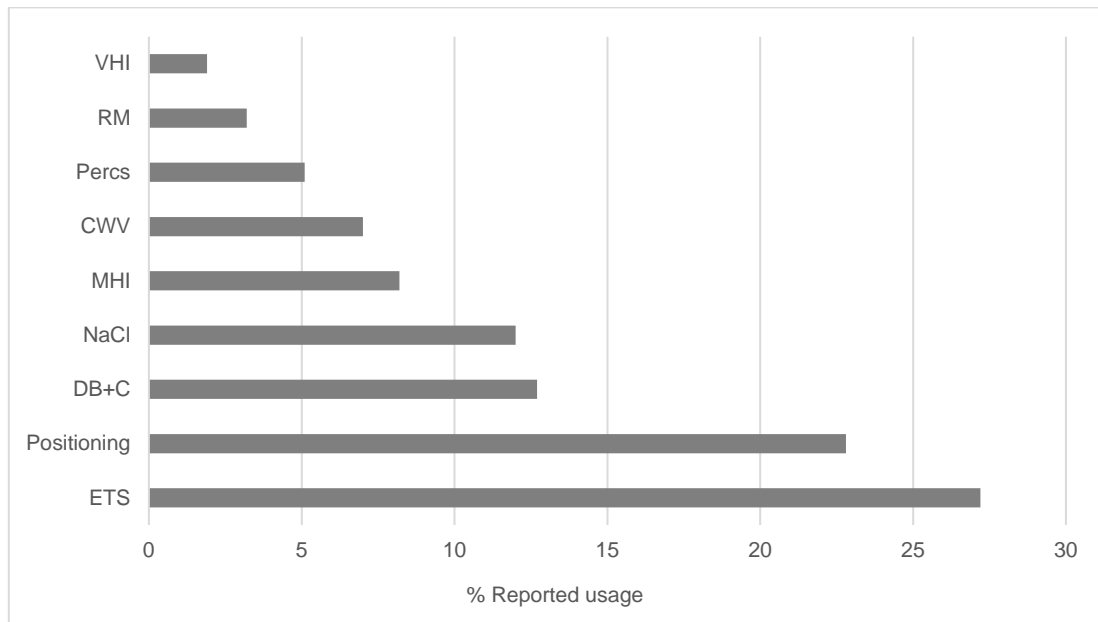
389 **Figure 3**



390

391

392 **Figure 4**



393

394 Abbreviations: CWV = chest wall vibrations, DB & C = deep breathing and coughing, ETS = endotracheal suction, MHI =  
395 manual hyperinflation, Percs = percussion, NaCl = normal saline administration, VHI = ventilator hyperinflation,  
396 RM = recruitment manoeuvre.

397