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The impact of nurse-directed protocolised-weaning from mechanical ventilation on nursing practice: A quasi-experimental study

Bronagh Blackwood, Jenifer Wilson-Barnett

*Nursing and Midwifery Research Unit, School of Nursing and Midwifery, Queen's University Belfast, 21 Stranmillis Road, Belfast, BT9 5AF, N. Ireland

Florence Nightingale School of Nursing and Midwifery, King's College London, James Clerk Maxwell Building, Waterloo, London, England

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Abstract

Background: Internationally, nurse-directed protocolised-weaning has been evaluated by measuring its impact on patient outcomes. The impact on nurses’ views and perceptions has been largely ignored.

Aim: To determine the change in intensive care nurses’ perceptions, satisfaction, knowledge and attitudes following the introduction of nurse-directed weaning. Additionally, views were obtained on how useful protocolised-weaning was to practice.

Methods: The sample comprised nurses working in general intensive care units in three university-affiliated hospitals. Nurse-directed protocolised-weaning was implemented in one unit (intervention group); two ICUs continued with usual doctor-led practice (control group). Nurses’ perceptions, satisfaction, knowledge and attitudes were measured by self-completed questionnaires before (Phase I) and after the implementation of nurse-directed weaning (Phase II) in all units.

Results: Response rates were 79% (n = 140) for Phase I and 62% (n = 132) for Phase II. Regression-based analyses showed that changes from Phase I to Phase II were not significantly different between the intervention and control groups. Sixty-nine nurses responded to both Phase I and II questionnaires. In the intervention group, these nurses scored their mean perceived level of knowledge higher in Phase II (6.39 vs 7.17, p = 0.01). In the control group, role perception (4.41 vs 4.22, p = 0.01) was lower and, perceived knowledge (6.03 vs 6.63, p = 0.04), awareness of weaning plans (6.09 vs 7.06, p = 0.01) and satisfaction with communication (5.28 vs 6.19, p = 0.01) were higher in Phase II. The intervention group found protocolised weaning useful in their practice (75%): this was scored significantly higher by junior and senior nurses than middle grade nurses (p = 0.02).

Conclusion: We conclude that nurse-directed protocolised-weaning had no effect on nurses’ views and perceptions due to the high level of satisfaction which encouraged nurses’ participation in weaning throughout. Control group changes are attributed to a ‘reactive effect’ from being study participants. Weaning protocols provide a uniform method of weaning practice and are particularly beneficial in providing safe guidance for junior staff.

Keywords: Clinical nursing research; Evaluation studies; Practice guidelines; Ventilator weaning

*Corresponding author.
E-mail address: b.blackwood@qub.ac.uk (B. Blackwood).

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What is already known about this topic?

Nurse-directed protocolised-weaning has the capacity to produce positive benefits for patients. The impact on nurses’ views and perceptions has not been evaluated.

What this study adds

Introducing nurse-directed protocolised-weaning had no effect on nurses’ perceptions, satisfaction, knowledge or attitudes to weaning. Effectiveness of protocolised-weaning appears to be influenced by existing intensive care unit working practices.

1. Introduction

1.1. Background

For more than 30 years there has been considerable research in the area of weaning patients from mechanical ventilation. Attempts to determine the best weaning method are inconclusive as no method was consistently superior across studies (Brochard et al., 1994; Esteban et al., 1995). However, evidence suggests that it is not the method of weaning that is important, but the fact that a standardised technique is used—in a protocol (Cook et al., 2000). Internationally the development and use of protocols in health care has attracted substantial research literature and a number of reasons have been suggested for developing clinical protocols. Two reasons cited most often are the integration of research evidence into practice (Robertson et al., 1996) and the reduction of variability in practice providing a more cost effective and efficient health care system (Chassin, 1990). It is claimed that the benefit for patients of using weaning protocols is a more appropriate timescale in the reduction of mechanical support which has been shown to be more effective in reducing time spent receiving mechanical ventilation. But the use of protocols is a controversial issue because of the contentious status of the research evidence and doctors’ perceptions that protocol rigidity will restrict professional freedom and autonomous practice (Blackwood et al., 2004; Tunis et al., 1994). It is suggested that nurses and allied health professionals tend to adhere to protocols more readily as a result of their different training and professional cultures (Lawton and Parker, 1999) and, indeed, the majority of studies evaluating the efficacy of weaning protocols have focused on comparing nurse or respiratory therapist (RT) led weaning using protocols with traditional doctor-led practice. The evidence is fairly evenly divided in both the adult and paediatric literature: some studies demonstrated more effective patient outcomes with protocolised-weaning (Ely et al., 1996; Farias et al., 1998; Grap et al., 2003; Horst et al., 1998; Kollef et al., 1997; Scheinhorn et al., 2001) and a similar number demonstrated no significant difference in outcomes (Blackwood et al., 2005; Burns et al., 1998; Djunaedi et al., 1997; Keogh et al., 2003; Krishnan et al., 2004; Randolph et al., 2002).

Outcome measures reported have focused primarily on patient measured features such as the duration of mechanical ventilation, weaning time and intensive care unit (ICU) stay. What tends to be over looked is that protocolised-weaning is not a standard intervention. It comprises not only weaning protocols, but its delivery depends on other interrelated components such as existing nursing, RT and medical weaning practices, methods of organising and delivering those practices and knowledge, attitudes and behaviours of those involved. If one is to determine whether the effectiveness of these interventions was due to their measured features or distinctive features of the site, staff or their interactions, then it is important to consider the ICU context and the perceptions of those delivering protocolised-weaning.

1.2. Evidence

The perceptions of nurses and RTs involved in protocolised-weaning have been largely ignored in the literature. Only one survey conducted in 1993 by the American Association of Critical Care Nurses (AACCN) explored weaning practices as perceived by critical care nurses (Clochesy et al., 1997). The survey required a random sample of AACCN nurses (n = 1000) to describe the factors that determined how they initiated and terminated weaning and their use of protocols and guidelines. There was a 40% (n = 403) response rate and only 50% of responders reported using structured weaning protocols. Those who did not use protocols described their preference to ‘individualise’ the weaning process according to patients’ needs, but this variability in practice may not be evidence-based or efficient. In research studies, if staff deviate from the protocol then it becomes difficult to ascertain whether measured outcomes are due to the protocol or staff influence.

When introducing behavioural change, an organisation’s culture and environment can also affect outcomes (Kitson et al., 1998; Pettigrew, 1988). In relation to clinical practice, Kitson et al. (1998) maintain that successfully implementing change relies on the interplay of evidence, context and facilitation that have a dynamic relationship positioned on a high–low level continuum. They hypothesise that successful implementation is more likely to occur when the evidence and context are ‘high’
and appropriate facilitation has been achieved. Context is defined as the environment or setting which includes the perceived culture (how staff are driven and valued and staff morale) and the nature of staff relationships (teamwork and organisation). It follows that if the context is ‘low’ then despite ‘high’ evidence, successful implementation may not be achieved. As a result, staff and working practices within ICUs may ultimately affect weaning outcomes.

The importance of context and its effect on patient outcomes was evident in the randomised controlled trial (RCT) conducted by Kollef et al. (1997) comparing protocolised-weaning by RTs and nurses with usual doctor-led weaning. Kollef and colleagues conducted their trial in 4 ICUs in 2 hospitals. When the data on patient outcomes were pooled and analysed altogether, they demonstrated a statistically significant reduction in the median duration of mechanical ventilation of 9 h ($p = 0.027$). However, within each unit, differences in weaning practice and staffing impacted on the efficacy of weaning protocols. Three ICUs were directed by full-time dedicated critical care doctors and 1 ICU had a part-time critical care doctor. When data from the 4 units were analysed separately, protocolised-weaning made a significant impact in only 1 unit. The 3 ICUs directed by critical care doctors demonstrated a reduction in the duration of mechanical ventilation ranging from 33.9 to 37.2 h in the protocol group, but this was only significant ($p = 0.019$) in 1 ICU. In the unit directed by the part-time critical care doctor (unit 4), weaning was previously delegated to the nurses who made autonomous decisions without waiting for medical orders. Introducing the weaning protocol in this unit had the least effect: the duration of mechanical ventilation was 7.9-h longer in the protocol group ($p = 0.799$). A possible explanation is that in ICUs where ventilation is routinely assessed on a frequent basis (by bedside nurses for example), one would not expect a marked benefit from protocols because mechanical support will be reduced in a timely manner. This assumption is somewhat supported by observing the control group data. In unit 4, the control group (following usual practice) had a much lower mean duration of mechanical ventilation (40.8-h) than the control groups in the other 3 units (107.2-h; 105.2-h; 114.3-h).

It is clear then that the mere introduction of protocolised-weaning is not sufficient to ensure that it will be accepted and followed and produce effective outcomes. The environment and the attitudes and perceptions of those using protocols also play a part in influencing outcomes. Hence, in evaluating the implementation of protocolised-weaning, in addition to evaluating patient outcomes, it is also necessary to incorporate an evaluation of these factors.

1.3. Relevance

Although international evidence strongly supports protocolised-weaning, it emanates mainly from North America where the differences in health care context can affect applicability of findings to other countries (Blackwood, 2003). Nevertheless, within the last 5 years, there has been a keen interest in introducing nurse-directed protocolised-weaning in the United Kingdom (UK). In 2000, a major review of the adult critical care provision by the Department of Health (DoH) for England and Wales (DoH, 2000) led to the establishment of a Modernisation Agency Critical Care Programme. The Agency launched critical care networks, comprising multi-professional critical care representatives from geographically linked National Health Service (NHS) Trust Hospitals, with a remit to develop and share critical care improvement projects. Since its inception, the Agency have reported over 351 improvement projects in progress and have registered the establishment of weaning protocols in 27 hospitals (NHS, 2003). Although several publications addressed the scope of nurse-directed weaning protocols in the UK (Crocker, 2002; Fulbrook et al., 2004; Lowe et al., 2001), none had rigorously assessed their impact upon weaning in terms of patient outcomes or nurses’ views and so there was a need for a robust evaluation of this practice.

1.4. Aims

The aims of this study were to develop and implement nurse-directed weaning using protocols and to evaluate their impact on patient outcomes and nurses’ views and perceptions. Findings from the patient outcomes component of this study are reported elsewhere (Blackwood et al., 2005). This paper focuses on the impact of nurse-directed protocolised-weaning on nurses.

2. Methods

2.1. Study design

The study was conducted in 3 ICUs at 3 university-affiliated teaching hospitals in Northern Ireland (NI) using a quasi-experimental, non-equivalent control group design (Campbell and Stanley, 1996). Each ICU had its own dedicated nursing staff: and the usual patient:nurse ratio was 1:1. Each ICU had assigned rotating doctors-in-training and the units were managed by a team of consultant anaesthetists who rotated between operating theatres and the ICU. During Phase I (Fig. 1), patients in all 3 units were weaned using traditional weaning practice. Traditional weaning practice is essentially a collaborative approach between doctors and nurses. Directed by broad guidelines,
dictated by the medical staff, nurses advance or delay the weaning steps according to the patient’s response. Generally no formal weaning criteria are used to determine the best time to start weaning and no formal guidelines for reducing support are used. Nurse-directed protocolised-weaning was subsequently introduced into unit 1 (intervention unit) while patients in units 2 and 3 (control units) continued with traditional weaning practice. Data pertaining to nurses’ views and perceptions were collected by questionnaire in all units before (Phase I, March 2002) and 9 months after (Phase II, November 2003) the implementation of nurse-directed protocolised-weaning in unit 1. Data were collected from units 2 and 3 to compensate for non-randomisation by providing potential explanations for any change in nursing practice. Two control units were recruited to ensure a balance in sample size because the intervention unit was a larger unit with more nurses and there was no similar sized unit with which to make a comparison. Between the 2 control units there were no significant differences in nurses’ perceptions, satisfaction, knowledge or attitudes, therefore data were combined to form a larger control group.

2.2. Sample and ethical considerations

The sample comprised the total population of nurses within the 3 units during the 2 phases of the study. Unqualified student nurses and qualified nurses on probation were excluded because they held supernumerary status. Characteristics of the participating units and their staff are presented in Table 1. The study was approved by Queen’s University Belfast Ethics Committee. An introductory letter invited staff participation and provided information on study requirements. Return of completed questionnaires was deemed as consent to participate.

2.3. The intervention

The patient’s bedside nurse assessed the patient’s readiness to wean every morning using predetermined readiness to wean criteria (daily wean screen): (a) respiratory rate <30 breaths/min; (b) $\text{PaO}_2$(kPa)/$\text{FiO}_2$ ratio >20; (c) systolic blood pressure >90 and <180 mmHg; (d) temperature <38.4 °C; (e) blood pH >7.3; haemoglobin ≥7.0 g/dl; (f) PEEP <5 cm H$_2$O; (g) tidal volume >5 ml/kg. Patients entered a weaning protocol when they met the readiness to wean criteria and their underlying indication for mechanical ventilation had resolved or significantly improved. The decision to wean was made by medical staff on the morning ‘round’. Using a weaning protocol (1 of 4) an individual weaning plan was drawn up on a sheet of paper for each patient, inserted in a plastic cover and attached to the patient’s ventilator. Patients progressed through the weaning protocol unless they met any of the predetermined respiratory fatigue criteria in which case the protocol was interrupted. These criteria included the following: (a) respiratory rate >35 breaths/min (sustained); (b) heart rate >140 beats/min (sustained); (c) $\text{SaO}_2$ <90%; (d) systolic blood pressure <90 or >180 mmHg; (e) blood pH <7.28; (f) uncoordinated chest movements; (g) the presence of agitation, anxiety,
diaphoresis or any pain limiting weaning. Re-initiation
of weaning usually occurred after a period of rest when
fatigue criteria normalised. If the patient did not
stabilise, weaning was suspended until they fulfilled the
readiness to wean criteria.

The unit was a major trauma centre with a diverse
patient population. In 2001, there were 538 admissions
and of those 88% were emergency cases and 12%
elective cases. Neurological patients (elective surgery,
emergency and non-operative) accounted for 39%,
surgical patients (elective and emergency) 42%, and
medical patients 19%. The diversity in diagnoses
resulted in variable weaning times. Data from a pilot
study indicated that total mechanical ventilation time
ranged from 2 to 1000 h, with 50% of patients free from
mechanical support at 91 h (Blackwood, 2005). To
support both short and long-term ventilation needs,
four weaning methods were used. Initially patients were
weaned from full support (e.g. the Synchronised
Intermittent Mandatory Ventilation [SIMV] mode)
using a stepwise reduction in respiratory rate. Short-
term ventilated patients usually required only a further
T-piece trial before extubation. Long-term ventilated
patients were generally supported on pressure support
or biphasic positive airway pressure ventilation for a
further period of time until they were ready to be
weaned. Although trials determining the superiority of
particular weaning methods are inconclusive (Brochard
et al., 1994; Esteban et al., 1995), it is suggested that the
SIMV method may lead to a longer weaning duration
(Butler et al., 1999). The four weaning methods reflected
previous local weaning practice and included an SIMV
protocol to achieve practitioner acceptance (Ely, 2000).

Four weaning protocols were developed. The medical
consultant decided which one to use and this usually
depended on the patient’s clinical condition and current
method of support.

(i) **SIMV Protocol.** Patients following this protocol
normally commenced from a set rate of 10–14 breaths/min, positive end expiratory pressure
(PEEP) of 5 cm H₂O and pressure support (PS) of
12–15 cm H₂O. The ventilatory rate was sub-
sequently decreased by 2–4 breaths/min every 2–4 h.
Patients who met weaning fatigue criteria had their
ventilatory rate increased by 2 breaths/min incre-
mental reductions in support following either the PS
or T-piece protocol.

(ii) **PS Protocol.** Patients following this protocol
normally commenced with a PEEP of ≤5 cm H₂O

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**Table 1**

Characteristics of participating units, staff and respondents

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Phase I control</th>
<th>Intervention</th>
<th>Phase II control</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of ICU beds</td>
<td>14</td>
<td>14a</td>
<td>14</td>
<td>15b</td>
</tr>
<tr>
<td>Consultant medical staff</td>
<td>14</td>
<td>5</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Total nursing staff numbers</td>
<td>91</td>
<td>102</td>
<td>99</td>
<td>128</td>
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<tr>
<td>WTE</td>
<td>83.85</td>
<td>84.53</td>
<td>104.72</td>
<td>112.87</td>
</tr>
<tr>
<td><strong>Grades</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>31</td>
<td>29</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>E</td>
<td>48</td>
<td>61</td>
<td>53</td>
<td>66</td>
</tr>
<tr>
<td>F/G/H</td>
<td>12</td>
<td>12</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Respondents</td>
<td>64</td>
<td>76</td>
<td>62</td>
<td>70</td>
</tr>
<tr>
<td>Age (mean years)</td>
<td>36</td>
<td>34</td>
<td>35</td>
<td>33</td>
</tr>
<tr>
<td>ICU experience (mean years)</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td><strong>Grades</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>22</td>
<td>25</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>E</td>
<td>31</td>
<td>39</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>F/G/H</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Completed CCC</td>
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<td>26</td>
<td>24</td>
<td>28</td>
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<tr>
<td>Undertaking CCC</td>
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<td>6</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

**WTE, whole time equivalents.**

UK nursing grades range from D [junior] to H [senior].

CCC = critical care course.

*a* In addition to 4 High Dependency Unit (HDU) beds.

*b* In addition to 5 HDU beds.
and PS 15–25 cm H\textsubscript{2}O. PS was reduced by 1–2 cm H\textsubscript{2}O every 2–4 h. Patients tolerating PS 10–12 cm H\textsubscript{2}O without fatigue commenced T-piece trials.

(iii) \textit{Intermittent T-piece Trial Protocol.} Patients following this protocol normally commenced with a PEEP of \(\leq 5\) cm H\textsubscript{2}O and PS 10 cm H\textsubscript{2}O. Increasing periods (duration 15, 30, 60, 120 and 240 min) on the T-piece circuit with CPAP were repeated during the day. Between periods, patients returned to their previous level of support. Removal of the endotracheal tube was discussed with medical staff if patients tolerated 4 h without fatigue.

(iv) \textit{Biphasic Positive Airway Pressure (BIPAP) Protocol.} Patients following this protocol received a reduction in ventilator pressure (P\textsubscript{insp}) every 2–4 h until the P\textsubscript{insp}-PEEP reached 10–12 cm H\textsubscript{2}O. Patients then continued incremental reductions in support following the SIMV and then PS protocols.

Extubation criteria were not included in the protocols and the decision to remove the patient’s endotracheal tube remained a medical decision.

2.4. Protocol implementation process

Between September 2001 and June 2002 a small multidisciplinary team was convened from the intervention unit and a series of regular meetings was set up to discuss the development and implementation of protocolised weaning in the unit. The team consisted of the ICU medical director, one ICU consultant, the senior sister (whose role later changed to critical care nurse consultant) and one of the authors (BB). A proposal was prepared for discussion with the directorate manager and senior staff in the unit. Throughout 2002 information about the change was communicated to staff through a number of existing channels. The ICU medical director formally communicated the proposals at the unit’s senior staff meetings (attended by the directorate manager, all consultants and senior nursing sisters) and informally through discussions with colleagues. Information was disseminated to junior nursing staff at team co-ordinators’ meetings and through the unit’s weekly staff bulletins in addition to the unit’s education seminars.

In July 2002 the daily wean screen protocol and the SIMV and T-piece trial weaning protocols were trialled by a small number of senior nursing staff; minor amendments were made. The nurse consultant was formally appointed in September 2002 and staff training began in November. An education programme was developed and delivered using formal and informal teaching sessions within the unit. Seven formal sessions were prepared and delivered by the critical care nurse consultant and two educational facilitators (senior sisters with an in-service training role). The sessions addressed the following:

1. respiratory assessment using the ‘Daily Wean Screen’
2. recognising respiratory fatigue
3. SIMV weaning protocol
4. pressure support weaning protocol
5. T-piece weaning protocol
6. BIPAP weaning protocol
7. use of the weaning plan.

Formal sessions were supplemented by informal bedside teaching sessions delivered by the education facilitators in addition to supervised support from senior staff on duty. A series of rolling sessions was delivered over a period of 3 months to capture all staff that rotated onto night duty. In January 2003 the protocols were fully implemented and copies were attached to each ventilator in the unit for easy referral by staff.

2.5. Study instrument

The impact of introducing a change in weaning practice can be evaluated by assessing its impact on the nurses who will use protocolised weaning. Resistance to change is generally characterised by lack of knowledge, confidence to adapt (Zaltman and Duncan, 1977) and differing views and feelings of already working in an effective manner (Robbins and Coulter, 2002), therefore conformity should be characterised by increased knowledge, confidence and views on the impact of change. Determination of knowledge, attitudes and confidence and how they changed over time required an objective measurement of these variables before and after the intervention; consequently a structured questionnaire was the most appropriate method for this study.

A review of the literature for relevant research tools pertinent to weaning from mechanical ventilation revealed a 7 item, semi-structured questionnaire by Clochesy et al. (1997) regarding weaning practices as perceived by critical care nurses. Nurses were required to describe the factors that determined initiation and termination of weaning and their views on the use of protocols and guidelines. These survey findings provided a framework for developing the structured questionnaire used in this study.

From Clochesy et al.’s (1997) survey, factors deemed important in initiating and terminating weaning stemmed from clinical assessment of the patient. The questionnaire in this study, therefore, incorporated 3 patient case scenarios from which scores were obtained on knowledge of patient assessment (both physiological and physical). In Clochesy et al.’s sample, those who did not have protocols described the weaning process as
dissatisfactory because weaning plans were undefined and uncoordinated while those who did not use protocols described their preference to ‘individualise’ the weaning process according to patients’ needs. The main concepts of satisfaction, communication, coordination, autonomy and individuality were thus incorporated into the structured questionnaire. Hence, the variables that were considered important to measure the impact of change were knowledge, confidence, satisfaction with communication about weaning plans and attitudes towards rigidity of protocols and their impact on autonomy and individualised care.

In addition to the nurses’ outcome measures, the Phase II questionnaire for the intervention group contained questions pertaining to the usefulness and implementation of protocolised-weaning in the unit. These areas were evaluated because the information and training received, and satisfaction with how this was implemented, may have impacted on how useful protocolised-weaning was perceived. Space was provided for elaboration of comments. The questionnaire is provided in an appendix.

2.6. Instrument validity and reliability

The quality and adequacy of the questionnaire was evaluated by establishing its validity and reliability. Content validity addressed the relevance and representativeness of the questions. The case scenarios were actual cases developed with guidance from an ICU medical consultant. Content validity was further supported by reference to the literature (particularly Clochesy et al.‘s survey finding) and from expert consultation. In August 2001 the questionnaire was distributed to an international panel of 7 experts in critical care with research experience to comment on its face and content validity and in October 2001 a sample of 4 ICU nurses completed a pilot questionnaire. Reliability was assessed with reference to the consistency with which experts and the pilot sample interpreted and answered questions. The 6-item scale measuring attitudes towards weaning protocols had good internal consistency with a Cronbach z coefficient of .80.

2.7. Data analysis

The questionnaires contained open and closed questions. Closed questions were coded. Descriptive statistics were used to describe the characteristics of the sample and categorical responses. In addition to frequencies, appropriate measures of central tendency and dispersion were used. Independent t-tests and ANOVA were used to test for differences between groups, the dependent t-test was used to test for differences within groups and multiple regression analysis was used to test for phase by group interactions. Responses to open-ended questions were subjected to a process of content analysis facilitating the formulation of categories. The data were subjected manually to a form of quantitative analysis, providing an indication of the frequency or prevalence among the sample of the categories that emerged.

3. Results

There was a 79% response rate from both groups in Phase I. The response rates in Phase II were 61% for the intervention group and 64% for the control group. The flow of nurses through the study is outlined in Fig. 2.

3.1. Comparisons of characteristics and outcomes between the intervention and control groups and between Phases I and II

In both phases of the study the characteristics of nurses were not significantly different between the intervention and control groups in terms of age, years qualified, years of ICU experience, numbers within each nursing grade and numbers undertaking or completed a post-registration critical care course (Table 1). During Phase I when all nurses were weaning patients from mechanical ventilation following traditional practice, there were significant differences in outcomes between the intervention and control groups. The intervention group was significantly more aware of weaning plans (7.1 vs 6.3, \( p = 0.02 \)); satisfied with communication (6.6 vs 5.5, \( p < 0.00 \)); satisfied with multi-disciplinary team (MDT) collaboration (6.5 vs 5.1, \( p < 0.00 \)); and had higher knowledge scores (17.4 vs 15.9, \( p = 0.02 \)). The control group had significantly higher attitude scores than the intervention group (24.4 vs 23.2, \( p = 0.04 \)). During Phase II, the intervention group’s satisfaction with MDT collaboration remained significantly higher than the control group (6.5 vs 5.2, \( p < 0.00 \)); and it had a significantly higher perception of weaning as part of the nurse’s role (4.4 vs 4.1, \( p = 0.01 \)) and perceived level of knowledge (6.8 vs 6.0, \( p < 0.00 \)).

In the control group, there were no significant differences in characteristics of nurses between Phases I and II. In the intervention group, nurses in Phase I were qualified significantly longer than nurses in Phase II (12 vs 9 years, \( p = 0.03 \)) and significantly more nurses were undertaking a critical care course in Phase II (6 vs 12 \( p = 0.01 \)). In the intervention and control groups, there were no significant differences in perceptions, satisfaction and knowledge scores of nurses between Phases I and II. In the control group, attitude scores of nurses were significantly lower in Phase II than nurses in Phase I (22.8 vs 24.4, \( p = 0.02 \)). Regression-based analysis demonstrated that changes from Phase I to Phase II in the intervention group were not significantly
different from Phase I to Phase II changes in the control group.

3.2. Findings from the ‘unique groups’

Sixty-nine nurses working in the units over the duration of the study period responded to questionnaires in both phases. These nurses formed a ‘unique group’ allowing comparisons of their perceptions, satisfaction, attitudes and knowledge scores over time. Following the introduction of protocolised weaning, the perceived level of knowledge of intervention group nurses was significantly higher than it had been in Phase I (7.1 vs 6.4, \( p = 0.01 \)). In Phase II, perceived level of
knowledge of control group nurses was also significantly higher (6.6 vs 6.0, \( p = 0.04 \)); awareness of weaning plans was significantly higher (7.1 vs 6.1, \( p = 0.01 \)); satisfaction with weaning communication was significantly higher (6.2 vs 5.3, \( p = 0.01 \)); and weaning as part of the nurse’s role was perceived significantly lower (4.2 vs 4.4, \( p = 0.01 \)).

The mean change in the intervention nurses’ scores from Phases I to II on all outcome measures were compared with the mean change in the control nurses’ scores from Phases I to II. The control group’s change was significantly larger than the intervention group’s change for weaning as part of the nurse’s role (−.19 vs .14, \( p = 0.01 \)) and awareness of weaning plans (−.97 vs .09, \( p = 0.04 \)).

3.3. Evaluation of protocolised-weaning

Following the implementation of protocolised-weaning, 93% (\( n = 65 \)) of intervention group nurses responded to the evaluation questions. Respondents included 29 D grade, 25 E grade and 11 F/G/H grade nurses. Responses to the usefulness of the wean screen, the daily plan and satisfaction with the implementation of protocolised-weaning were grouped according to grade to explore whether protocolised-weaning was considered more useful by particular grades of staff.

On average, E grade nurses found the daily wean screen, weaning plan and satisfaction with the implementation of protocolised-weaning were grouped according to grade to explore whether protocolised-weaning was considered more useful by particular grades of staff. Usefulness of the daily wean screen was rated significantly lower by E grades than the F/G/H grades and F/G/H grades rated satisfaction with implementation of protocolised-weaning significantly higher than E and D grades (Table 2).

Seventy-five percent (\( n = 49 \)) of nurses stated that protocolised-weaning had been useful in their practice. There were significantly more D and F/G/H grades (\( F = 4.3, \text{df} \ 2, \ p = .02 \)) agreeing that protocolised-weaning was useful in practice than E grades (Fig. 4). Qualitative responses provided insight into why the majority of D and F/G/H grades felt protocolised-weaning was useful and why the majority of E grades were unsure.

Twenty-five nurses referred to the positive benefits gained from having a structured guide. Many comments were made suggesting that weaning protocols were appropriate for new and junior nurses that have yet to accrue the knowledge necessary to wean patients confidently.

As a newly qualified staff nurse in ICU I found it beneficial to have a plan to follow until I became more familiar with the weaning process. (D grade 256)

As a newly qualified nurse, ventilators can be difficult to understand. The wean screen and protocols have helped me to follow certain guidelines to successful weaning and a better understanding of the whole process. (D grade 266)

More junior staff with guidelines...feel more confident to wean patients. (E grade 140)

I think it has provided clear guidelines and structure to weaning in many cases. It has also increased the knowledge of nurses regarding weaning and ventilation. (F/G/H grade 67)

Six responses from D and F/G/H grade nurses highlighted that the guidelines increased nurse autonomy by providing guidance and aiding decision-making:

Per criteria and protocol if I feel the patient is happy enough to be weaned with doctor’s consent, the guidelines could easily be followed without having to refer to the doctor every now and then. (D grade 242)

Nurse (need) not depend on the doctor order only—you can ... know your patient well and assess properly on weaning process, practise decision-making and initiative. (D grade 248)

Conversely, E grade nurses were cautious about relying closely to the structure and felt that protocols restricted their professional freedom and autonomous practice.

...professional judgment is still important. (E grade 56)

I feel protocols restrict the autonomy of the nurse to provide individualised patient centred care. While they might provide a direction, without proper
education and clinical support in implementing a personal patient assessment and empowering nursing staff to make decisions...they are not worth the paper they are written on. (E grade 253)

For many experienced nurses weaning protocols simply reflect their current weaning practice; the information is ‘in their heads’ so they did not actually find the protocols of extra benefit for them.

Was already taking the lead and weaning prior to the protocol. (E grade 129)

I feel we have always weaned patients this anyway and did not find the protocol structure, now in place, to be of any more benefit than traditional methods. (E grade 114)

Provides guidelines and increased continuity of care, it was already being done on the unit but there were no specific guidelines. (E grade 147)

4. Discussion

In this study, we tested the hypothesis that implementation of nurse-directed protocolised-weaning would positively influence nurses’ (a) perceptions; (b) satisfaction with weaning communication; (c) knowledge; and (d) attitudes towards protocol guidelines. None of the outcomes tested reached statistical significance and therefore the hypothesis cannot be accepted. Nurses in the intervention group reported greater satisfaction with their current weaning practice than the control group. They were more aware of weaning plans for their patients and were more satisfied with weaning communication and multi-disciplinary collaboration. The existing good weaning practice within the unit may have contributed to the reason why there was no difference in outcomes thus supporting the assumption that context influences outcomes. It is striking that the average scores for the nursing outcome measures were clustered at the high end of the scale. With such high scores at the outset, only a very potent intervention would have the capacity to provide a statistically significant change.

Involvement in collaborative practice ultimately increases one’s experience and knowledge (Gaberson and Oermann, 1999; Spencer, 2004) and this may account for the intervention group’s higher knowledge of weaning management vis-à-vis the control group. As a result of the more positive collaborative culture one might have expected higher attitudes scores, but these were higher in the control group. It may be that the

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<th>Mean (SD)</th>
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<td>F/G/H</td>
<td>E</td>
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<tr>
<td>Usefulness of wean screen</td>
<td>7.3 (1.9)</td>
<td>4.9 (1.9)</td>
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<tr>
<td>Usefulness of weaning plan</td>
<td>7.0 (1.6)</td>
<td>5.4 (2.0)</td>
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<tr>
<td>Satisfaction/implementation</td>
<td>7.3 (1.6)</td>
<td>5.3 (2.2)</td>
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<tr>
<td>Usefulness of wean screen *(F/G/H &amp; D)</td>
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<tr>
<td>Usefulness of weaning plan *(E) *(F/G/H)</td>
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<td>Satisfaction/implementation *(E &amp; D)</td>
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*Statistically significant.
*One-way analysis of variance (ANOVA) with Duncan’s post hoc test.

Fig. 4. Nursing grade responses to usefulness of protocolised-weaning in practice.
intervention nurses felt that protocols would detract from their collaborative weaning practice.

In Phase II there were changes in the intervention unit’s structure. The unit increased in size by 2 additional beds, 4 new medical consultants and an additional 28.34 WTE nursing staff. With so many new and relatively inexperienced staff one might have expected some turbulence in the settling-in period as new staff adapt to the unit’s ‘ways of working’. Despite this, perceptions of weaning as part of the nurse’s role and satisfaction with multi-disciplinary communication remained high and indeed higher than that of the control group. This suggests that despite turbulent changes, the culture within the unit remained stable over time. The fact that the intervention unit’s perceptions, satisfaction, knowledge and attitudes about weaning were not significantly different between time periods suggests that the introduction of weaning protocols may have had some positive effect by providing structure, guidance and consistency in weaning practice. This assumption is supported by the qualitative and quantitative findings.

Protocolised-weaning provided a structured set of guidelines to follow for junior nurses. They found this particularly useful as they often lacked experience in weaning and following guidelines helped them feel more comfortable and confident. The unit’s senior nurses (F/G/H grades) work in a management role either as unit managers or team co-ordinators and they have responsibility for monitoring safe practice. They felt that by providing a structure the protocols contributed to safe nursing practice particularly for the inexperienced. E grade nurses have more ICU experience than D grades and provide more continuous patient care than the unit sisters provide. It follows that they would have more confidence in making weaning decisions based on their assessment of the patient. It would appear that the reason they did not find protocols as useful as the other grades is that they had already internalised their own weaning style and resented restrictions (in the form of structure) to their autonomy.

The non-significant results may be attributable to several other issues. The lack of change may be an expression of the incapacity of the protocols used to induce change. The protocol used in this study incorporated readiness to wean criteria (wean screen), but did not incorporate nurse autonomy to commence a 2-h spontaneous breathing trial (SBT) for the patient on passing the criteria. Those studies that incorporated daily wean screens and SBTs in their protocols demonstrated significant reductions in mechanical ventilation time (Ely et al., 1996; Grap et al., 2003; Horst et al., 1998; Marelich et al., 2000; Saura et al., 1996). It was not possible in this study to gain agreement from medical consultants to incorporate a SBT into the protocol. Reasons for consultants’ reticence was the need to maintain control over the weaning process because of the disparate group of patients and unease about protocols being strictly applied by inexperienced staff (Blackwood et al., 2004). In addition, nurses’ orders to proceed with weaning had to be obtained on the morning ward round before initiating weaning. Thus, it is possible that the nurse-directed protocols used in this study caused some frustration for experienced nurses who, formerly, would have proceeded to reduce mechanical support and thus resulted in a longer timescale in reducing support than had been previously practised.

Another possible explanation for the non-significant results is that attitudes and knowledge may only change after implementing protocols on a long-term basis. The learning curve theory asserts that internalising new behaviours is slow to start but the user becomes more proficient over time (Atherton, 2003). In this study, the time frame in measuring outcomes 9-months after introducing protocolised-weaning may have been too optimistic to allow for change. Furthermore, the mean age of respondents was 34 years with average ICU experience of 8 years. It is possible that a change agent such as protocolised-weaning may produce a higher impact on a younger and less experienced group of nurses.

It is possible that the scales used within the questionnaire were not adequate to measure the attributes of interest. Due to the novelty of this study, we have no reference data on the measurement levels of nurses’ views in this area under scrutiny. The attitude scale proved to have good internal consistency, but the other scales were used for the first time and it is possible that they were not sensitive enough to detect small differences in perceptions, satisfaction and knowledge.

Despite the non-significant changes in the intervention group, there were unexpected changes in the control group. In Phase II, control nurses reported greater satisfaction with awareness of weaning plans and communication regarding weaning and they rated their perceived level of knowledge higher. A possible explanation is that the findings resulted from a ‘reactive (Hawthorne) effect’, where the effect of ‘being studied’ influences behaviour and attitudes (Roethlisberger and Dickson, 1939, cited in Bowling, 2002). At the time of issuing the Phase II questionnaires, data collection for evaluating patient outcomes had been ongoing in one of the control units for 3 years. There is a possibility that the long continued presence of one of the authors in this control unit unintentionally raised greater awareness of weaning among the medical and nursing staff encouraging more collegiality. This theory fails to explain, however, the control group’s significantly lower perception that weaning is part of the nurse’s role in Phase II. Perhaps the ‘reactive effect’ encouraged more
collegiality in weaning, but not independence by nurses in making weaning decisions. An interesting further study would be to establish whether the introduction of nurse-directed weaning protocols in this unit changes this perception.

On the basis of the results from this trial in the UK, we conclude that nurses’ perceptions, satisfaction, knowledge and attitudes towards weaning were more stable than expected and we question the capacity of nurse-directed protocolised-weaning to induce nursing practice change at the level addressed here. Nurse-directed protocolised-weaning has the capacity to reduce mechanical ventilation time for patients. Such positive outcomes appear to be influenced by existing working practices in intensive care units and it may be useful to consider the culture of the ICU and the views and perceptions of staff delivering weaning practice. This research suggests that successful implementation of protocolised-weaning will require achieving a balance between providing consistent practice guidelines and allowing experienced nurses to use their clinical judgement where necessary.

Acknowledgements

The authors thank the nursing staff from the units for agreeing to take part in the study and providing necessary data and Dr. Steve Wainwright for providing advice on previous drafts. This study was supported by an All-Ireland Nursing Research Fellowship grant from An Bord Altranais, Dublin, Ireland.

Appendix A. Questionnaire for ICU nurses on ventilator weaning practice

Section 1: This section addresses questions about yourself and your background

1. What is your clinical grade? D  E  F  G
2. What age are you? (in years) ___________________
3. In what year did you qualify as a registered nurse? ___________________
4. How many years of ICU experience do you have? __________________
5. Have you completed a specialist practice post-registration critical care/intensive care course? Yes  No
6. Are you currently undertaking a specialist practice post-registration critical care/intensive care course? Yes  No

Please indicate your views by circling your response to the following statements.

7. I consider weaning as part of the nurse’s role.

   1  2  3  4  5
   Strongly disagree  Disagree  Uncertain  Agree  Strongly agree

8. I feel confident about managing a patient who is weaning from mechanical ventilation

   1  2  3  4  5
   Strongly disagree  Disagree  Uncertain  Agree  Strongly agree
9. On a scale of 1–10, please rate how you perceive your level of knowledge about the weaning process (circle a number).

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<td>Knowledgeable Expert</td>
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Section 2: This section addresses your perspectives on what currently happens when weaning patients from mechanical ventilation

10. Think back over the last few weeks to patients you have cared for and who were being weaned. When your patients were being weaned for the first time, to what extent were you made aware of the weaning plan/goals for that day/shift? (circle a number)

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<td>Vaguely aware Fairly aware Mainly aware Very aware</td>
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11. To what extent were you satisfied with communication regarding patients’ daily weaning plan/goals? (circle a number)

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12. To what extent were you satisfied that your management of weaning patients was a multidisciplinary collaboration? (circle a number)

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<td>Not Low satisfaction Fairly satisfied Mainly satisfied Very satisfied</td>
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Section 3: In this section I have picked out some case histories and would be grateful if you would work through these indicating what you think.

Case 1

Mr. Brown was admitted for exacerbation of his chronic obstructive pulmonary disease complicated by left lower lobe pneumonia. He required intubation and mechanical ventilation soon after hospital admission. His medical history includes a 25 year smoking history and COPD which was diagnosed 5 years ago. He weighs 90 kgs. Before this hospitalisation, he had been treated with beta-agonists and ipratroprium inhalers.

Despite several attempts at weaning, he had one failed extubation and has not been able to maintain unassisted spontaneous breathing for longer than 24 h. Consequently, he received a tracheostomy. The ICU consultant has chosen pressure support ventilation (PSV) as the mode of weaning. Mr. Brown is receiving FiO2 0.4, PSV of +8 cm H₂O pressure and +5 cm H₂O continuous positive airway pressure (CPAP) during his weaning trials. He maintains approximately 4 h off full support (on CPAP) and his resting mode is SIMV.

13. During weaning, what respiratory signs would you monitor to assess his progress?

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
14. What range would you accept as normal parameters for respiratory rate during weaning? (*circle highest and lowest value*)

4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

15. After 1 h of weaning his \( \text{PaCO}_2 \) increases to 7 kPa (it had previously been 6 kPa). What would you do? (*circle one response*)

(a) increase the \( \text{FiO}_2 \)
(b) decrease the \( \text{FiO}_2 \)
(c) increase the pressure support
(d) increase the CPAP
(e) do nothing

16. What cardiovascular signs would indicate to you that Mr. Brown was not tolerating weaning? (*circle one response*)

(a) bradycardia and hypertension
(b) bradycardia and hypotension
(c) tachycardia and hypertension
(d) tachycardia and hypotension

17. What other signs or symptoms would indicate that Mr. Brown was not tolerating weaning?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Case 2
Mrs. Green has had surgery for breast cancer. She has suffered weight loss and now weighs 45 kg. Following surgery she developed a chest infection and left pleural effusion and is admitted to the ICU with respiratory distress. She requires antibiotic therapy and drainage of the effusion.

Currently Mrs. Green is on SIMV mode on the ventilator. The set tidal volume is 500 ml, respiratory rate is 10 breaths/min, PEEP is 3, \( \text{FiO}_2 \) is 0.8 and pressure support is 10.

Mrs. Green is breathing 28–33 spontaneous breaths/minute and her actual tidal volume is 250 mls. Her arterial blood gas results are as follows:

\[
\begin{align*}
PO_2 & \quad 8.9 \text{ kPa} \\
PCO_2 & \quad 7.2 \text{ kPa} \\
\text{PH} & \quad 7.24 \\
\text{BE} & \quad -3.7
\end{align*}
\]

18. Is this patient suitable for weaning? Yes [ ] No [ ]

19. Give several reasons to support your decision.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

20. How would you improve \( PO_2 \)? (*circle one response*)

(a) increase \( \text{FiO}_2 \)
(b) reduce PEEP
(c) increase set respiratory rate
(d) increase PEEP

21. Would you want to correct the \( PCO_2 \)? Yes [ ] No [ ]

22. How does one correct the \( PCO_2 \)? (*Circle one response*)

(a) increase \( \text{FiO}_2 \)
(b) reduce pressure support
(c) increase set respiratory rate
(d) increase PEEP
Case 3
Mr. Wilson undergoes a repair of an abdominal aortic aneurysm. He has no renal dysfunction and is back on the vascular ward. He develops a paralytic ileus and has a grossly distended abdomen. Previously he smoked 40 cigarettes/day and is obese weighing 105 kg. He develops respiratory distress with a respiratory rate of 40 breaths/min and he is admitted to the ICU.

23. What range of \( PO_2 \) values would you accept for this patient? (circle one response)
(a) 6–8 kPa
(b) 8–10 kPa
(c) 10–12 kPa

24. What \( PCO_2 \) values would you expect this patient to have in his ‘normal’ pre-operative state? (circle one response)
(a) 4–5.5 kPa
(b) 5–6.5 kPa
(c) 6.5–8 kPa

25. On a CPAP mask the patient’s \( PO_2 \) increases to 16.8 kPa and his respiratory rate falls to 34. Is his respiratory status now satisfactory?
Yes [ ] No [ ]

26. What other clinical information would you like to know?
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

Mr. Wilson requires SIMV, antibiotics, and high levels of sedation. He makes good progress over the next 10 days. He is now on CPAP mode on the ventilator with a pressure support of 15. He has no metabolic acidosis. His arterial blood gas results are as follows:

\[ PO_2 \quad 9.5 \text{ kPa} \]
\[ PCO_2 \quad 8.8 \]
\[ \text{PH} \quad 7.22 \]

His respiratory rate is 22 breaths/min

27. Which result (or results) above do you feel needs correction? (circle one response)
(a) \( PO_2 \) only
(b) \( PCO_2 \) only
(c) pH only
(d) \( PO_2 \) & \( PCO_2 \)
(e) \( PCO_2 \) & pH
(f) \( PO_2 \) & pH
(g) \( PO_2 \), \( PCO_2 \) & pH

28. How would you do this? (circle one response)
(a) increase pressure support
(b) decrease pressure support
(c) put the patient back on SIMV mode
(d) increase CPAP
(e) decrease \( FiO_2 \)

Section 4: This section addresses your views on the use of protocol guidelines in weaning

These statements are designed to elicit your views on the use of protocol guidelines in weaning. Please tick the response that best fits your view.
Weaning protocols:

<table>
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<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Unsure</th>
<th>Agree</th>
<th>Strongly agree</th>
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<tr>
<td>29</td>
<td>…increase my autonomy in the weaning process</td>
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<td>30</td>
<td>…impair individualised care</td>
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<td>31</td>
<td>…provide structured direction</td>
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<td>32</td>
<td>…restrict decision making</td>
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<td>33</td>
<td>…are beneficial for patients</td>
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<td>34</td>
<td>…diminish professional practice</td>
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35. To what extent do you find the daily wean screen useful in assessing patients’ readiness to wean?

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<td></td>
<td>Not useful</td>
<td>Fairly useful</td>
<td>Mainly useful</td>
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36. To what extent do you find the weaning plan useful in communicating patients’ weaning progress?

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37. Have you received any explanation/training on the:

(a) Daily wean screen
    (b) Weaning plan
    (c) SIMV
    (d) Pressure support
    (e) CPAP circuit
    (f) BIPAP

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<th>Yes</th>
<th>No</th>
<th>Not sure</th>
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38. If you have not received explanation/training, please can you tell me why?

- I have not been given the opportunity
- I did not think it would be useful
- There was no-one to cover my work
- I was already familiar with the guidelines
39. To what extent were you satisfied with the explanation/training during the implementation of protocolised weaning in the unit?

1 2 3 4 5 6 7 8 9 10
Not Low satisfaction Fairly satisfied Mainly satisfied Very satisfied

40. How could this have been improved?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

41. Do you think the introduction of protocolised weaning has been useful in your weaning practice?

Yes ☐ No ☐ Not sure ☐

Please elaborate

____________________________________________________________________
____________________________________________________________________

Thank you for taking the time and effort to complete this questionnaire. Your participation is very much appreciated.

References
