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ORIGINAL

# National survey on airway and difficult airway management in intensive care units☆

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**KEYWORDS**
Airway;
Difficult airway;
Intubation;
Questionnaire

**Abstract**
*Objective:* To know organization, management and training in airway (AW) in Spanish Intensive Care Units (ICUs), with special interest in difficult airway (DAW).
*Design:* Descriptive cross-sectional study and $\chi^2$ subanalysis, conducted through a national survey from November 1st to December 15th, 2016. With the SEMICYUC's support, an online questionnaire of 27 items was sent to 179 ICUs.
*Setting:* ICUs of public, private centers, and consortia.
*Results:* In total, 101 units responded (56.4%), corresponding to 1827 beds and almost 95,000 incomes/year. The 85.1% are public hospitals, and 83.2% had residents. Of the responders, 22.8% do not use routinely AW assessment scales, being the most frequently used the Cormack–Mallampati association (35.6%). There is no intubation (IOT) protocol in 77.2%, or DAW protocol in 75.2%. An 82.2% have a DAW cart. The 48.5% have training in IOT, and in VAD 53.5%. Having a DAW expert is significantly associated with greater training in IOT (60% vs. 39.3%; $p = 0.03$), DAW (64.4% vs. 44.6%; $p = 0.04$), and more AW protocols (73.4% vs. 37.5%; $p = 0.000$). Having a specific guideline for DAW management in UCI is considered necessary in 99%.
*Conclusions:* There is room for improvement in AW management. It is necessary to identify an expert in DAW in each Unit, and the development of a specific guideline for DAW management in critical care.


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**PALABRAS CLAVE**
Vía aérea;
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Intubación;
Cuestionario

**Encuesta nacional sobre el manejo de la vía aérea y la vía aérea difícil en las unidades de cuidados intensivos**

**Resumen**
*Objetivo:* Conocer la organización, el manejo y la formación en vía aérea (VA) en las unidades de cuidados intensivos (UCI) españolas, con especial interés en la vía aérea difícil (VAD).
*Diseño:* Estudio transversal descriptivo y subanálisis con $\chi^2$, elaborado mediante una encuesta nacional realizada del 1 de noviembre al 15 de diciembre de 2016. Con el aval de la SEMICYUC, se envió a 179 UCI un cuestionario online con 27 apartados.
*Ámbito:* UCI de hospitales públicos, privados y consorcios.
*Resultados:* Responden 101 UCI (56,4%), que suponen 1.827 camas y casi 95.000 ingresos/año. El 85,1% son hospitales públicos, y el 83,2%, con residentes. El 22,8% no utilizan rutinariamente escalas de valoración de VA, siendo la más frecuente la asociación Cormack-Mallampati (35,6%). El 77,2% no tienen protocolo de intubación (IOT), ni el 75,2% protocolo de VAD. El 82,2% tienen carro de VAD. El 48,5% refieren formación en IOT, y el 53,5%, en VAD. Identificar a un experto en VAD se asocia significativamente con mayor formación en IOT (60% vs. 39,3%; p = 0,03), VAD (64,4% vs. 44,6%; p = 0,04) y más protocolos de VA (73,4% vs. 37,5%; p = 0,000). El 99% estima necesario disponer de una guía específica de manejo de VAD en UCI.
*Conclusiones:* Existe un amplio margen de mejora para el manejo de la VA. Es necesario identificar un experto en VAD en cada unidad y elaborar una guía específica de manejo de VAD en el paciente crítico.


## Introduction

Correct management of the airway (AW) and difficult airway (DAW) is crucial in the Intensive Care Unit (ICU). The intubation of a critical patient poses risks that often need to be faced by intensivists in their daily practice. In effect, serious complications may occur in up to 30–40% of all intubations, including severe hypoxemia, arrhythmias and even cardiac arrest and permanent anoxic brain damage. Patient death has been reported in up to 1–2% of the cases.[1–4] The poor physiological reserves of the critical patient when intubated, and the variable experience of the professional carrying out the procedure, imply that this must be regarded as a risk technique in all patients admitted to the ICU. Furthermore, the mentioned complications are even more frequent in the case of reintubation, since in such situations there are often added anatomical alterations that complicate the procedure[4–6] or certain risk populations may be involved, such as morbidly obese individuals.[7] This has led some authors to consider that *a priori*, all AW should be regarded as DAW.[8]

The definition of DAW has not been well established, but includes difficulty in performing mask ventilation, the need for multiple intubation attempts, inadequate vision of the glottis, or the appearance of complications during the procedure.[8] This classification of DAW can be influenced by the introduction of new instruments and techniques resulting from technological advances seen in recent years, and which seek to facilitate the intubation process. Their usefulness and positioning within the DAW management protocol have not yet been clearly defined. However, based on the available evidence, the use of a videolaryngoscope is included in the clinical practice guides on DAW management.[9]

Information is lacking on how DAW management is organized in Spanish ICUs. In other words, we have no recent or past data on the approach to this problem, the interventional schemes used, the training received by intensivists, the technology available in the ICU to deal with DAW, or the number of ICUs that have an identified leader or expert in DAW as recommended by the Fourth National Audit Project of the Royal College of Anaesthetists and Difficult Airway Society (NAP4).[10]

We therefore decided to conduct a national survey on the management of AW and particularly DAW in Spanish ICUs, with a view to determining the organization, available resources and existing training programs. Furthermore, we aimed to examine whether these aspects differ according to the size of the Unit, the presence or not of an ICU expert in AW management, or accreditation of the Unit in the training of specialists in Intensive Care Medicine.

## Material and methods

A cross-sectional national survey was carried out, auspiced by the Scientific Committee of the Spanish Society of Intensive and Critical Care Medicine and Coronary Units (*Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias*, SEMICYUC). Approval from the Clinical Research Ethics Committee was not requested, due to the voluntary nature of participation and the fact that patient data were not collected. All the information obtained was managed on an anonymized basis to protect confidentiality.


**Figure 1** Distribution by Spanish provinces of the hospitals participating in the survey.

A 27-item questionnaire was developed (see table in Supplementary electronic material) including multiple response questions and divided into three parts: organizational aspects of the ICU, airway management and available materials and training issues – together with a final section referred to comments and suggestions. The following DAW assessment scales were used: Mallampati–Samsoon, Cormack–Lehane, mandibular subluxation, 3:3:2 rule and extension of the atlantooccipital joint.[11] With regard to the videolaryngoscopes, we asked for information on the availability of any of the following systems: probe type (Bonfils); with standard rigid blade (V-MAC® or C-MAC®); with angled rigid blade (GlideScope® or McGrath®); or with a canal integrating the endotracheal tube (Airtraq®, Pentax AWS® or C-TRACH®).[12]

From the Secretariat of the SEMICYUC, an e-mail was sent to all the ICUs identified at that date, addressed to the Heads of Department and explaining the project and its objectives. The e-mail contained the link providing access to the survey (https://goo.gl/forms/xRsWRSqUMHZTL7FY2). Successive e-mails sent by the research team served to encourage participation and resolve any doubts.

## Statistical analysis

The data were reported as absolute numbers and percentages in the case of quantitative variables, and as the median and interquartile range (IQR) in the case of continuous variables. The chi-squared test was used to establish comparisons between the above defined subgroups. The number of beds in the different ICUs was classified into three groups: fewer than 10, between 10–20, and over 20. Statistical significance was considered for $p < 0.05$ in two-tailed testing. The SPSS version 20.0 statistical package was used throughout.

## Results

The survey was carried out from 1 November, 2016 to 15 December of that same year. A total of 101 ICUs of the 179 invited to participate answered the survey (56.4%). The geographical distribution of the participating Units is shown in Fig. 1. Table 1 in turn summarizes the organizational characteristics of the centers that answered the survey. Most of them were public hospitals with resident training programs. Seventy-one of the questionnaires were answered by the Head of Department, 24 by the AW expert in the ICU, and 6 by other staff members of the Unit. Polyvalent ICUs predominated, with a median of 16 beds. The total beds in the study sample was 1827, corresponding to about 95,600 admissions yearly.

Table 2 presents the results globally and according to the size of the ICU referred to different aspects of AW management and the contents of the DAW cart. Among all the participating ICUs, an expert or leader in DAW was only identified in 45 (44.5%). The most commonly used AW assessment

**Table 1** Characteristics of the participating Intensive Care Units.

| | |
|---|---|
| Type of hospital | Public: 86 (85.1%)<br>Private: 11 (10.9%)<br>Consortium: 4 (4%) |
| University hospital | 70 (69.3%) |
| Resident training | 84 (83.2%) |
| Type of ICU | Polyvalent: 92 (91.1%)<br>Medical: 5 (5%)<br>Others: 4 (4%) |
| Beds per hospital (median) | 424 (240–770) |
| Beds in ICU (median) | 16 (9–25) |
| Annual admissions to ICU (median) | 800 (500–1.200) |
| Physicians on duty in ICU (other than residents) (median) | 2 |

scale was found to be the Cormack–Lehane scale, alone or in combination with the Mallampati scale. Twenty-three of the Units did not make routine use of any AW assessment scale, and 55 (54.5%) did not record AW assessment in the patient clinical history. With regard to written protocols, 77.2% of the ICUs had no orotracheal intubation protocol, and in 75.2% of the Units the approach to DAW was not protocolized.

According to the data obtained, 83 of the participating ICUs had a DAW cart, which was periodically checked for contents. These checks were mostly made on a weekly basis (66.3%) and to a lesser extent every two weeks (7.2%) or every three or more weeks (13.3%). A total of 11 ICUs (13.3%) reported no established frequency for checking the cart. In most Units basic material was available for intubation (laryngoscopes and endotracheal tubes), along with a laryngeal mask, intubation laryngeal mask and an emergency cricothyroidotomy kit. With regard to the specific type of videolaryngoscope used in those ICUs that had such a device (53.3%), the Airtraq® predominated (42.6%), followed by GlideScope® (10.9%) and McGrath® (6.9%).

In relation to training issues, 52 ICUs (51.5%) provided continued training in intubation, and 54 (53.5%) reported continued specific training in DAW. As regards the place where such training was provided, most reported training on an external basis. Only 21.8% of the Units had DAW simulation mannequins.

On establishing comparisons on the basis of the size of the ICU, only the availability of a fibrobronchoscope was seen to increase significantly with the size of the Unit: 43.2% (>20 beds), 43.3% (11–20 beds) and 11.76% (0–10 beds) ($p = 0.04$).

Table 3 shows AW management and the DAW cart contents according to whether an expert in DAW was identified or not. A significant relationship was observed between the presence of a leader or expert in DAW and the existence of written protocols on orotracheal intubation (33.3% vs. 14.3% in the case of no such expert; $p = 0.02$), DAW management (44.4% vs. 8.9%; $p = 0.000$), extubation in DAW (17.8% vs. 1.8%; $p = 0.006$) and the performance of percutaneous tracheostomy (51.1% vs. 28.6%; $p = 0.01$). Statistical significance was also observed for the association between the presence of an expert and the availability of a videolaryngoscope (66.7% vs. 42.8%; $p = 0.01$), fibrobronchoscope (46.6% vs. 21.4%; $p = 0.006$) and cricothyroidotomy kit (84.4% vs. 66.1%; $p = 0.04$). Likewise, the presence of an expert in DAW was significantly correlated to training in intubation (60% vs. 39.3%; $p = 0.03$) and training in DAW (64.4% vs. 44.6%; $p = 0.03$).

Lastly, no statistically significant relations were found on contrasting the questionnaire findings with respect to whether the Unit was accredited in the training of intensivists or not. One hundred of the 101 participants (99%) considered it necessary to have a specific clinical guide on DAW management in intensive care.

## Discussion

This is the first available national survey on the management of AW, and specifically on the management of DAW, in Spanish ICUs. Its results evidence great heterogeneity in the approach to DAW. Only about 50% of the ICUs have written protocols for AW management or identify a leader or expert in DAW management, and the presence of the latter is associated to better training and equipment for DAW management.

Some studies have concluded that the introduction of an intubation protocol in the ICU can reduce the immediate serious complications related to the procedure.[13] This reduction not only affects the complication related to AW management but also hemodynamic or neurological alterations which are common in the critically ill during performance of the technique. Furthermore, according to our data, the existence of a specific protocol for DAW management is found in only a few of the Units that answered our questionnaire, and this is consistent with the observations in other countries.[14–16] It has been postulated that such protocols are one of the strategies needed to improve the success rates in intubations posing risk and reduce the associated complications.[9] Other protocols referred for example to patient extubation in cases of DAW or displacement of the tracheostomy, have also been recommended by the experts,[17] but were available in very few of the consulted ICUs. Of note is the common presence in the ICUs of protocols referred to percutaneous tracheostomy, which is a technique generally performed on an elective basis.[18]

Identifying patients with possible DAW allows an improved approach to the airway.[19] However, according to our data, in almost one-half of the cases AW evaluation is not recorded in the patient clinical history. As a result, potentially valuable information in emergency situations or future admissions is omitted.[9] The use of a single assessment scale has low sensitivity, low specificity and a low positive predictive value. These parameters are all improved upon when several scales are used together.[20] As in other surveys, the most widely used predictors were the Mallampati–Cormack combination, followed by the Cormack scale alone. This implies that in most situations these are patients that have undergone direct laryngoscopy on some occasion (e.g., after surgery). Little use is made of combined simple predictors (thyroid-chin distance, oral opening, etc.) at the patient

**Table 2** Airway management and contents of the difficult airway cart according to Intensive Care Unit size.

| Number of beds in ICU | 0–10 (*N* = 34) | 11–20 (*N* = 30) | ≥21 (*N* = 37) | Total |
|---|---|---|---|---|
| *Identification of an expert in DAW* | 12 (35.35) | 12 (40%) | 21 (56.8%) | 45 (44.6%) |
| *Registry of AW assessment in the clinical history* | 20 (58.8%) | 13 (43.3%) | 22 (59.5%) | 55 (54.5%) |
| *Assessment scales used* | | | | |
| None | 8 (23.5%) | 9 (30%) | 6 (16.2%) | 23 (22.8%) |
| Mallampati + Cormack | 10 (29.4%) | 8 (26.7%) | 18 (48.6%) | 36 (35.6%) |
| Cormack–Lehane | 10 (29.4%) | 7 (23.3%) | 6 (16.2%) | 23 (22.8%) |
| Mallampati–Samsoon | 1 (2.9%) | 1 (3.3%) | 1 (2.7%) | 3 (3%) |
| Cormack and other scale | 0 | 1 (3.3%) | 3 (8.1%) | 4 (4%) |
| Mallampati and other scale | 0 | 1 (3.3%) | 1 (2.7%) | 2 (2%) |
| More than 2 scales | 4 (11.8%) | 3 (10%) | 2 (5.4%) | 9 (8.9%) |
| Others | 1 (2.9%) | 0 | 0 | 1 (1%) |
| *Written protocols for AW management* | | | | |
| Orotracheal intubation | 8 (23.5%) | 3 (10%) | 12 (32.4%) | 23 (22.8%) |
| Difficult airway management | 9 (26.5%) | 8 (26.7%) | 8 (21.6%) | 25 (24.8%) |
| Extubation | 1 (2.9%) | 8 (26.7%) | 9 (24.3%) | 18 (17.8%) |
| Percutaneous tracheostomy | 12 (35.3%) | 15 (50%) | 12 (32.4%) | 39 (38.6%) |
| Auto-extubation | 1 (2.9%) | 0 | 1 (2.7%) | 2 (2%) |
| Extubation in DAW | 2 (5.9%) | 3 (10%) | 4 (10.8%) | 9 (8.9%) |
| *Analysis of the complications and incidents related to intubation/extubation* | 24 (70.65) | 14 (50%) | 17 (45.9%) | 44 (44.45) |
| *Availability of DAW cart* | 29 (85.3%) | 23 (76.7%) | 31 (83.8%) | 83 (82.2%) |
| *Periodic checks of DAW cart* | 29 (85.3%) | 23 (76.7%) | 30 (81.1%) | 82 (81.2%) |
| *Contents of DAW cart* | | | | |
| Laryngoscopes | 30 (88.2%) | 21 (70%) | 31 (83.8%) | 82 (81.2%) |
| Endotracheal tubes | 29 (85.3%) | 21 (70%) | 31 (83.8%) | 81 (80.2%) |
| Laryngeal mask | 27 (79.4%) | 22 (73.3%) | 26 (70.3%) | 75 (74.3%) |
| Intubation laryngeal mask | 24 (70.6%) | 21 (70%) | 29 (78.4%) | 74 (73.3%) |
| Videolaryngoscope | 16 (47.1%) | 15 (50%) | 23 (62.2%) | 54 (53.5%) |
| Eschmann guide | 24 (70.6%) | 13 (43.3%) | 24 (64.9%) | 61 (60.4%) |
| Fibrobronchoscope | 4 (11.8%)* | 13 (43.3%)* | 16 (43.2%)* | 33 (32.7%) |
| Cricothyroidotomy kit | 28 (82.4%) | 21 (70%) | 26 (70.3%) | 75 (74.3%) |

* $p < 0.05$.

bedside, despite the fact that they are easy to record and are potentially useful.[21]

The clinical practice guides and expert documents recommend that all ICUs should have a ''difficult intubation cart''.[9,22] Such a cart was available in 82% of the ICUs in our survey, although this percentage is lower than that recorded in other studies in our setting, with figures in the range of 95%.[23,24] Furthermore, the cart contents are very heterogeneous, with three out of every four ICUs having a cricothyroidotomy kit, laryngeal mask or intubation laryngeal mask.[23] A recent survey in the United Kingdom concluded that only 50% of all ICUs have a videolaryngoscope – this figure being very similar to that observed in our own study.[25] In contrast, the percentage was even lower (24%) in a survey conducted in France in 2013.[24] Based on the available evidence, it is increasingly common for videolaryngoscopy to be included in the clinical practice guides on DAW management.[9,26] This contrasts with the observation that only one-half of the surveyed Spanish ICUs possess such a system, in coincidence with the findings in the United Kingdom.

The identification in the ICU of a leader or expert in DAW clearly improves the resources and training available for dealing with DAW. We consider this fact to be very important, since it can result in better management of DAW and fewer complications. In the same way that the presence of a leader in concrete care aspects should be available in the ICU in other contexts of critical patient management,[27] we consider that our data confirm the need for an expert in DAW in each Unit.

Training in AW and DAW management was only found in one-half of the ICUs, and in most cases training was provided on an external basis. Such training should be targeted to both the specialists and to the physicians in training.[22] Only one out of every 5 Units in our survey reported having DAW simulation mannequins – despite the fact that training with mannequins and simulators is known to be useful for learning and the improvement of skills in intubation.[28]

**Table 3** Airway management and contents of the difficult airway cart according to the presence of an expert in difficult airway.

| | Identification of an expert in DAW $n = 45$ | No identification of an expert in DAW $n = 56$ |
|---|---|---|
| *Registry of AW assessment in the clinical history* | 28 (62.2%) | 27 (48.2%) |
| *Assessment scales used* | | |
| None | 5 (11.1%) | 18 (32.1%) |
| Mallampati + Cormack | 19 (42.2%) | 17 (30.4%) |
| Cormack–Lehane | 10 (22.2%) | 13 (23.2%) |
| Mallampati–Samsoon | 0 | 3 (5.4%) |
| Cormack and other scale | 4 (8.9%) | 0 |
| Mallampati and other scale | 1 (2.2%) | 1 (1.8%) |
| More than 2 scales | 5 (11.1%) | 4 (7.1%) |
| Others | 1 (2.2%) | 0 |
| *Written protocols for AW management* | | |
| Orotracheal intubation | 15 (33.3%)* | 8 (14.3%)* |
| Difficult airway management | 20 (44.4%)* | 5 (8.9%)* |
| Extubation | 11 (24.4%) | 7 (12.5%) |
| Percutaneous tracheostomy | 23 (51.1%)* | 16 (28.6%)* |
| Auto-extubation | 1 (2.2%) | 1 (1.8%) |
| Extubation in DAW | 8 (17.8%)* | 1 (1.8%)* |
| *Analysis of the complications and incidents related to intubation/extubation* | 27 (60%) | 28 (51.9%) |
| *Availability of DAW cart* | 42 (93.3%) | 41 (73.2%) |
| *Periodic checks of DAW cart* | 42 (93.3%) | 40 (71.4%) |
| *Contents of the DAW cart* | | |
| Laryngoscopes | 41 (91.1%) | 41 (73.2%) |
| Endotracheal tubes | 41 (91.1%) | 40 (71.4%) |
| Laryngeal mask | 39 (86.7%) | 36 (64.3%) |
| Intubation laryngeal mask | 37 (82.2%) | 37 (66.1%) |
| Videolaryngoscope | 30 (66.7%)* | 24 (42.9%)* |
| Eschmann guide | 32 (71.1%) | 29 (51.8%) |
| Fibrobronchoscope | 21 (46.7%)* | 12 (21.4%)* |
| Cricothyroidotomy kit | 38 (84.4%)* | 37 (66.1%)* |

* $p < 0.05$.

The probability of encountering complicated intubation is greater in intensive care than in other healthcare settings. Despite this fact, to date the existing clinical practice guides in this field have been developed by anesthetists and focus on the intraoperative setting, with the inclusion in some cases of guidelines on AW management in the ICU or in the out-hospital setting.[9,22,29–32] However, there are important differences between patients scheduled for surgery and critical patients – the latter generally being intubated due to pre-existing oxygenation/ventilation failure, and under conditions of hemodynamic instability. In this regard, it must be underscored that all the surveyed Units except one considered it necessary to have a specific clinical guide on DAW management in the intensive care setting.

Our study has some limitations. On one hand, the response rate was about 55%; as a result, the information collected might not reflect the true situation in Spanish ICUs. Nevertheless, we consider it important to underscore that the ICUs that did participate in the survey included those pertaining to most of the large public hospitals in the country – this implying a large number of ICU beds and many annual admissions to intensive care. On the other hand, as with all surveys, the information was collected from the answers of those interviewed. As a result, the data obtained do not necessarily reflect the true situation. Lastly, it is possible that the professionals most interested in the subject of our study were precisely those that participated in the survey – a situation that would bias the results obtained.

In sum, our findings show that there is clear room for improvement in organizational and training issues with a view to optimizing DAW management in Spanish ICUs. Each Unit should identify a leader or expert in AW and DAW management, since the presence of such a professional is associated with improved organization, training and equipment for dealing with DAW. The results of this survey should serve as a first step towards the development of a specific clinical guide on DAW management in critical care, auspiced by the SEMICYUC.

## Authorship

I.M.R. and J.G.M. contributed to the conception of the present study. I.M.R., J.G.M., M.G.G.P., M.R.M and J.R.J.V. participated in the design and data acquisition. The interpretation of the data and the statistical analysis were carried out by M.G.G.P., J.G.M. and M.R.M.C. In addition to drafting of the manuscript, J.R.J.V. contributed to the supplementary material. J.G.M., I.M.R. and M.G.G.P. conducted a critical review of the intellectual content. All the authors read and approved the final version of the manuscript.

## Conflicts of interest

The authors declare that they have no conflicts of interest.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.medine.2018.09.008.

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