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Review Article

Tools used to assess comfort among patients undergoing high flow nasal cannula: A scoping review

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ABSTRACT

Objective: The aims were twofold: (a) to map tools documented in the literature to evaluate comfort among patients undergoing high flow nasal cannula (HFNC) treatment; and (b) to assess if the retrieved tools have been validated for this purpose.

Methods: A scoping review, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR). In July 2023, PubMed, Scopus, CINAHL and Cochrane Library were consulted. Studies assessing comfort in adult, paediatric, and neonatal patients undergoing HFNC were included.

Results: Seventy-four articles were included, among which nine (12.2 %) investigated comfort as the primary aim. Twenty-five different tools were found, classifiable into 14 types, mostly unidimensional and originating from those measuring pain. The most widely used was the Visual Analogic Scale (n = 27, 35.6 %) followed by the Numerical Rating Scale (n = 11, 14.5 %) and less defined generic tools (n = 10, 13.2 %) with different metrics (e.g. 0–5, 0–10, 0–100). Only the General Comfort Questionnaire and the Comfort Scale were specifically validated for the assessment of comfort among adults and children, respectively.

Conclusion: Although the comfort of patients undergoing HFNC is widely investigated in the literature, there is a scarcity of tools specifically validated in this field. Those used have been validated mainly to assess pain, suggesting the need to inform patients to prevent confusion while measuring comfort during HFNC and to develop more research in the field.

Implications for clinical practice: Comfort assessment is an important aspect of nursing care. Given the lack of validation studies in the field, efforts in research are recommended.

Introduction

The high flow nasal cannula (HFNC) is a system that delivers 30–60 L/min of humidified air and oxygen mixture at a defined oxygen concentration (21–100 %) and temperature (31–37 °C) through a nasal interface (Hernández et al., 2017). HFNC was established in 2001 to manage apnoea of prematurity (Sreenan et al., 2001); then, it has been an increasingly used treatment in clinical practice for both children and adult patients, especially in the intensive care unit (ICU), emergency departments, non-operating room anaesthesia settings (e.g. radiology, endoscopy units) (Tao et al., 2022) and, recently, also in some medical and surgical units (Pirret et al., 2017; Colombo et al., 2022). HFNC has numerous physiological benefits relating to respiratory rate and breathing work reduction, to which are added optimal humidification of the inspiratory mixture while the patient can speak, drink and eat (Mukherjee & Mukherjee, 2023). For these reasons, higher levels of comfort have been observed among patients undergoing HFNC compared to conventional oxygen therapy (Ischaki et al., 2017) or non-invasive ventilation (Ovtcharenko et al., 2022). However, during HFNC treatment, the patient's comfort could be compromised if the flow and temperature are not set correctly, and the size of nasal cannulas is not appropriate to the size of the nostrils (Mauri et al., 2018). Discomfort leads to negative outcomes, such as lower tolerance in continuing the treatment, resulting in attempts to remove the device, thus worsening the respiratory condition (Galazzi et al., 2019). Considering that better comfort promotes the patient's adherence to the treatment its measurement should be ensured over time (Ricard et al., 2020). However, no recommendations have been provided to date: no indications regarding how to assess comfort among these patients in the current HFNC therapy guidelines (Rochwerg et al., 2020; Oczkowski et al., 2022; Huang et al., 2023).

Comfort is defined as a state of wellbeing that should be promoted

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during any phase of the illness-health continuum; it is also considered an individualized and holistic experience (Lorente et al., 2017). Lack of comfort may affect the perceived quality and safety of a patient during the in-hospital stay. The National Institute for Health and Care Excellence Patient Experience Guideline has identified comfort as one of the outcomes of a good patient experience within the National Health Service (Wensley et al., 2020); in addition, comfort has been considered a fundamental outcome of nursing, informing therapeutic nursing actions (Morse, 1992). Several instruments have been validated to measure comfort, mainly multidimensional; however, none of tools traced in the literature (Lorente et al., 2018) has been considered in the context of HFNC. Moreover, to our best knowledge, no studies mapping the tools to evaluate comfort among patients undergoing HFNC have been published to date. Therefore, the aims of this scoping review were: (a) to map tools used in studies evaluating comfort among patients undergoing HFNC treatment; and (b) to assess if the retrieved tools have been validated for this purpose.

Methods

Design

A scoping review was performed according to the framework by Arksey and O'Malley (2005), further developed by Levac et al. (2010), following the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidance (Tricco et al., 2018) (Supplementary Table 1). The research protocol was designed and submitted to the University of Udine, Italy, on 20 May 2023.

Search questions

The search questions were as follows: (a) What tools have been used to date in studies evaluating comfort among patients undergoing HFNC? and (b) Have these tools been validated to detect comfort among these patients?

Search strategy

The PubMed, Scopus, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Cochrane Library databases were searched up to 27 July 2023. According to the population, exposure and outcome (PEO) framework (Calderon Martinez et al., 2023) there were identified the following key words: "high flow nasal cannula" and "comfort". The key words were combined in different search strings as reported in the Supplementary Table 2. The search for articles was carried out by a junior (MP) and a senior (AG) nurse researchers – educated at the bachelor and doctoral level, respectively. They process was performed before independently; then, disagreements were resolved with a third expert nurse researcher – doctorate educated and experienced in research methodologies (AP).

Inclusion and exclusion criteria

Primary quantitative studies (interventional and observational) concerning adult, paediatrics, and neonatal patients, evaluating comfort during HFNC, and published in English or Italian were all included. Reviews were excluded, though references were assessed to retrieved potential primary studies, along with retracted articles, grey literature, and studies not indicating the tools used to assess comfort. No time frame limits were applied. Quality assessment of the included studies was not performed (Arksey and O'Malley, 2005).

Search outcome

All records retrieved were assessed to exclude duplications; the remaining studies were screened by title, abstract, and keywords against the inclusion criteria. Two researchers (MP, AG) screened independently; in case of disagreement, a third researcher (AP) was consulted. The same process was performed regarding all eligible studies identified, the full texts of which were carefully read. The PRISMA flow diagram (Page et al., 2021) was used to represent the entire study selection process.

Data extraction and synthesis

The data extracted from the included studies concerned: author(s), journal, year of publication, aim(s), design, sample, setting and country, type of tools measuring comfort, and data regarding their validation. The data extraction grid was developed and then piloted in two studies by two researchers (MP, AG); no changes were required. Data extraction was then performed independently by the same two researchers (MP, AG), and a third researcher (AP) was consulted in case of disagreements.

Data extracted were described in a narrative manner (Popay et al., 2006). Specifically, included studies were described in their main characteristics; then, to answer the research questions, the names of the tools measuring comfort, their main characteristics, their composition as unidimensional (only one/multiple items) or multidimensional (multiple factors), and metric ranges were described; when reported in the body of the manuscript and/or as a reference, data regarding validation of the tool in the context of HFNC comfort were also summarized.

Results

Study selection

As described in Fig. 1, a total of 649 records were found by the databases: 231 from Scopus, 210 from Cochrane Library, 148 from PubMed, and 60 from CINAHL. After removing duplicates and reading titles, abstracts, and full texts, 60 articles were retained according to the inclusion and exclusion criteria. Fourteen articles were added after reference screening of the reviews found. Finally, 74 articles were included.

Study characteristics

As reported in Table 1 and in Supplementary Table 3, studies were published between 2010 and 2023, one third between 2021 (n = 15, 20.3 %) and 2022 (n = 9, 12.2 %), mainly in medical journals (n = 72, 97.3 %) of pneumology (n = 21, 28.5 %), e.g. *Respiratory Care* (Stéphan et al., 2017), *Pulmonology* (Carratalá et al., 2023), and intensive care (n = 20, 27.0 %), e.g. *Critical Care* (Lemiale et al., 2015), *Journal of Critical Care* (Butt et al., 2021). Only two studies (2.7 %) were published in nursing journals: *International Journal of Nursing Studies* (Parke et al., 2012), *Research in Nursing and Health* (Jing et al., 2019). Around half of them (n = 34; 46 %) were performed in Europe (e.g. Roca et al., 2010). At the country level, 11 studies (14.9 %) were conducted in Italy (e.g. Cortegiani et al., 2019), nine (12.2 %) in China (e.g. Jing et al., 2019) and nine (12.2 %) in France.

Most studies (n = 65, 87.8 %) assessed the comfort as a secondary aim, e.g. comparing the effects of HFNC versus the Venturi mask (Maggiore et al., 2014) whereas in nine (12.2 %) the perceived comfort the primary study aim. Studies included were mostly interventional in their design (n = 59, 79.7 %) (e.g. Schwabbauer et al., 2014) and five (7.5 %) were designed as pilot studies (Sztrymf et al., 2011; Song et al., 2017; Sarkar et al., 2018; Nakanishi et al., 2020; Criner et al., 2022). Regarding the target population, there were included mainly adult patients (n = 61, 82.4 %) (e.g. Frat et al., 2015), five (7.5 %) with healthy adult volunteers (Garofalo et al., 2019; Delorme et al., 2021; Köhler et al., 2022; Yao et al., 2022; Johnson et al., 2023). Included studies involved a total of 6,818 participants, from six (Valencia-Ramos et al., 2018; Narang et al., 2021) to 830 (Stéphan et al., 2017); more than half

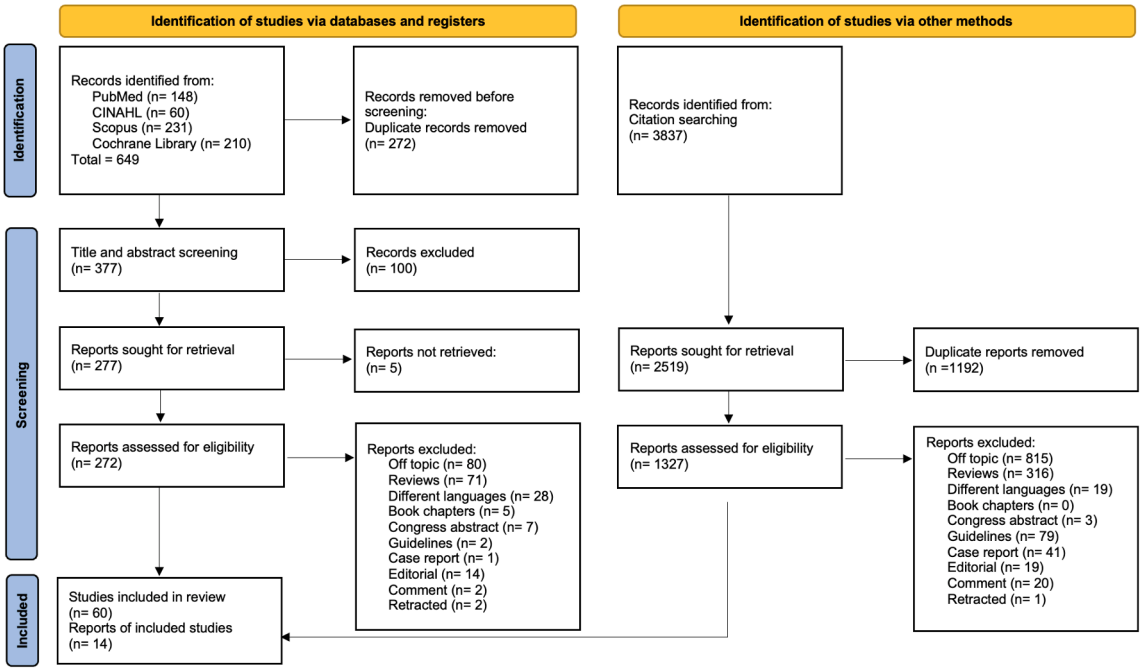


Fig. 1. PRISMA flow diagram from Page et al. (2021). Legend: CINAHL, Cumulative Index to Nursing and Allied Health Literature.

of them involved fewer than 25 (n = 23, 31.1 %) (e.g. Chanques et al., 2013) or up to 50 participants (n = 17, 23 %) (e.g. Jing et al., 2019).

The main settings were general ICU (n = 25, 33.8 %) (e.g. Lemiale et al., 2015) and specialist ICUs (n = 14, 18.9 %), such as surgical (e.g. Xuan et al., 2021), medical (e.g. Artaud-Macari et al., 2021) or cardiothoracic (e.g. Theologou et al., 2021). Overall, 30 studies (40.5 %) were conducted in tertiary or university hospitals (e.g. Bell et al., 2015; Futier et al., 2016) and the remaining 43 (58.1 %) in community hospitals (e.g. Suzuki et al., 2020), with one study (1.3 %) at patients' homes (Criner et al., 2022). Seventeen studies (23 %) were multicentre in nature.

Tools to measure comfort

To evaluate comfort, 25 different tools were used, classifiable into 14 types, as summarized in Table 2. In 18 studies (24.3 %) (e.g. Sztrymf et al., 2011), participants were specifically asked to evaluate their discomfort level rather than their comfort level. The level of comfort was self-reported in 67 studies (90.5 %) by patients (e.g. Vargas et al., 2015) or by healthy volunteers (e.g. Köhler et al., 2022) undergoing HFNC treatment, while in seven studies (9.5 %) concerning paediatric and neonatal subjects (e.g. Yoder et al., 2013), the comfort was evaluated by healthcare professionals, mainly by bedside nurses (e.g. Klingenberg et al., 2014). Comfort or discomfort were generally assessed with a single tool: only two studies (Valencia-Ramos et al., 2018; Matsuda et al., 2020) used two tools, comparing the score of the COMFORT Behavior tool (COMFORT-B) with that of the Visual Analogic Scale (VAS), and using the Numerical Rating Scale (NRS) or the Face Scale, respectively. In two studies (2.7 %) (Nakanishi et al., 2020; Yilmazel Ucar et al., 2021), there was used a closed-ended question by asking patients if they were comfortable or not.

Studies used mostly unidimensional tools composed by only one item; the widely used was the VAS (n = 27, 35.6 %), followed by the NRS (n = 11; 14.5 %), the Visual Numeric Scale (VNS) (n = 4; 5.3 %) and the Verbal NRS (n = 2; 2.6 %). Across these tools, metrics ranged from 0–5 to 0–100 as reported in Table 2. Generic scales developed by authors were also largely used (n = 10; 13.2 %) followed by Likert scales (n = 8; 10.8 %) also in these cases with different metrics and ranges. The Face Scale was used in four studies (5.3 %), adding a number under faces ranging from 0 to 5 (Tiruvoipati et al., 2010; Merry et al., 2022; Yao et al., 2022) and from 0 to 10 (Matsuda et al., 2020), specifically called the Face Pain Scale.

Tools with multiple items, whose sum indicates the level of comfort, were also used. These included the Comfort Scale (Bueno Campaña et al., 2014; Sarkar et al., 2018), based on four items; the COMFORT-B (Valencia-Ramos et al., 2018; Valencia-Ramos et al., 2019), with six items; the COMFORT score (Shah et al., 2021), with eight items; the General Comfort Questionnaire (GCQ) (Xu & Liu, 2021), including 29 items; the Pulmonary Function Status and Dyspnea Questionnaire (PFSDQ) (Liu et al., 2023), providing three domains; and the Échelle Douleur Inconfort Nouveau-né - neonatal pain and discomfort scale (EDIN) (Klingenberg et al., 2014), with 5 items.

The GCQ (Xu & Liu, 2021) for adults and the Comfort Scale (Bueno Campaña et al., 2014; Sarkar et al., 2018) for children were specifically developed to assess comfort. The GCQ was previously validated while the Comfort Scale was partially validated; the COMFORT score (Shah et al., 2021) and the COMFORT-B (Valencia-Ramos et al., 2018; Valencia-Ramos et al., 2019) were tools developed and validated to detect the level of stress in children. The EDIN was developed and partially validated to assess pain in premature infants (Klingenberg et al., 2014).

Discussion

Study characteristics

This scoping review mapped tools used to measure comfort in patients undergoing HFNC treatment among published studies. Though the HFNC was established in 2001 (Sreenan et al., 2001), this treatment has been widely documented especially after 2020 in the context of Coronavirus (COVID-19) pandemic (Arruda et al., 2023). Europe and Asia emerged as the leading continents in measuring comfort during HFNC, likely because they were first affected by the pandemic. However, comfort was set as the primary aim in only a few studies, suggesting that clinical effectiveness has been considered more important that the patient's experience and adaptation to the HFNC treatment.

Studies available have been published mainly in medical journals and a few in the nursing field suggesting that more efforts are needed, given that comfort is considered a nurse sensitive outcome (Kolcaba,

Table 1
Characteristics of the included studies.

Characteristics	N = 74 (100 %)
Publication year	
2010–2015	17 (23.0)
2016–2020	28 (37.8)
After 2020	29 (39.2)
Journal subject	
Pneumology	21 (28.5)
Intensive care	20 (27.0)
Multi specialties	13 (17.6)
Anesthesiology	4 (5.4)
Emergency	3 (4.1)
Pediatric	4 (5.4)
Nursing	2 (2.7)
Oncology	2 (2.7)
Physiology	2 (2.7)
Medical informatics	1 (1.3)
Otolaryngology	1 (1.3)
Toxicology	1 (1.3)
Country	
Europe	34 (46.0)
Asia	22 (29.7)
Oceania	9 (12.2)
America	8 (10.8)
Africa	1 (1.3)
Aim	
Comfort as primary aim	9 (12.2)
Comfort as secondary aim	65 (87.8)
Design	
Interventional	59 (79.7)
Observational prospective	12 (16.2)
Observational retrospective	3 (4.1)
Sample	
Adults	66 (88.5)
Pediatrics	5 (7.5)
Neonates	2 (2.7)
Mixed	1 (1.3)
Setting	
Intensive care unit	39 (52.4)
Mixed units	8 (10.8)
Emergency department	6 (8.0)
Respiratory unit	5 (7.5)
Operating room	3 (4.1)
Laboratory unit	2 (2.7)
Oncology unit	1 (1.3)
Neonatal unit	1 (1.3)
Pediatric unit	1 (1.3)
Stroke unit	1 (1.3)
Patient home	1 (1.3)
Not specified	6 (8.0)

Data are presented as counts and percentage (%).

1992). The body of evidence produced to date originates mainly from interventional studies enrolling mostly adults, monocentric in nature, and with samples of fewer than 50 individuals. More than half of the studies were conducted in ICUs where HFNC has been most used to date (Pirret et al., 2017; Colombo et al., 2022).

Tools to measure comfort

Overall, tools used in this research field to date trigger four lines of discussion.

Firstly, several instruments, mainly measuring comfort as self-reported by patients, have been used, suggesting that this research

Table 2
Tools used to assess patients' comfort during HFNC treatment.

Tools (metric ranges)	N = 76 (100 %)	Authors
Adult		
VAS	27 (35.6)	
(0–10)	25 (33.0)	Roca et al., 2010; Rittayamai et al., 2014; Frat et al., 2015; Lemiale et al., 2015; Delorme et al., 2017; Song et al., 2017; Reminiac et al., 2018; Spoletini et al., 2018; Valencia-Ramos et al., 2018**; Grieco et al., 2020; Alptekinoğlu Mendil et al., 2021; Butt et al., 2021; Carlucci et al., 2021; Delorme et al., 2021; Narang et al., 2021; Robert et al., 2021; Theologou et al., 2021; Xuan et al., 2021; Agmy et al., 2022; Colombo et al., 2022; Criner et al., 2022; Tsai et al., 2022; Carratalá et al., 2023; Hao et al., 2023; Johnson et al., 2023
(1–10)	2 (2.6)	Tan et al., 2020; Khan et al., 2022
NRS	11 (14.5)	
(0–10)	10 (13.2)	Chanques et al., 2013; Maggiore et al., 2014; Rittayamai et al., 2015; Futier et al., 2016; Garofalo et al., 2019; Longhini et al., 2019; Cortegiani et al., 2019; Matsuda et al., 2020**; Suzuki et al., 2020; Theerawit et al., 2021
(1–10)	1 (1.3)	Schwabbauer et al., 2014
Generical tool not better defined	10 (13.2)	
(0–5)	1 (1.3)	Peeters et al., 2021
(0–10)	3 (4.0)	Fraser et al., 2016; Yuan et al., 2020; Artaud-Macari et al., 2021
(0–100)	1 (1.3)	McKinstry et al., 2019
(1–5	3 (4.0)	Haywood et al., 2019; Köhler et al., 2022; Ghezzi et al., 2023
(1–10)	2 (2.6)	Bräunlich et al., 2016; Jing et al., 2019
Likert scale*	7 (9.2)	
(1–4)	1 (1.3)	Lucangelo et al., 2012
(1–5)	4 (5.3)	Bell et al., 2015; Vargas et al., 2015; Stéphan et al., 2017; Sahin et al., 2018
(1–10)	2 (2.6)	Tan et al., 2019; Wu et al., 2022
Face Scale	4 (5.3)	
(0–5)	3 (4.0)	Tiruvoipati et al., 2010; Merry et al., 2022; Yao et al., 2022
(0–10)	1 (1.3)	Matsuda et al., 2020**
VNS	4 (5.3)	
(1–5)	1 (1.3)	Mauri et al., 2018
(0–10)	3 (4)	Sztrymf et al., 2011; Basile et al., 2020; Li et al., 2021
Verbal NRS (0–10)	2 (2.6)	Parke et al., 2012; Ozturan et al., 2019
Direct closed-ended question (yes or no)	2 (2.6)	Nakanishi et al., 2020; Yilmazel Ucar et al., 2021
GCQ (29 items, 29–174)	1 (1.3)	Xu & Liu, 2021
PFSDQ (3 items, 0–10 for each item)	1 (1.3)	Liu et al., 2023
Pediatric		
Comfort Scale (4 items, 4–16)	2 (2.6)	Bueno Campaña et al., 2014; Sarkar et al., 2018
COMFORT-B (6 items, 6–30)	2 (2.6)	Valencia-Ramos et al., 2018**; Valencia-Ramos et al., 2019
COMFORT score (8 items, 8–40)	1 (1.3)	Shah et al., 2021
Neonatal		
Likert scale* (1–3)	1 (1.3)	Yoder et al., 2013
EDIN scale (5 items, 0–15)	1 (1.3)	Klingenberg et al., 2014

Data are presented as counts and percentage (%). Legend: COMFORT-B, Comfort Behavior scale; EDIN, Échelle Douleur Inconfort Nouveau-né (neonatal pain and discomfort scale); GCQ General Comfort Questionnaire; NRS, Numerical Rating Scale; PFSDQ, Pulmonary Function Status and Dyspnea Questionnaire; VAS, Visual Analogical Scale; VNS, Visual Numeric Scale. * Same tool, different population. ** Same article, two tools.

field has embodied the Patient Reported Outcomes perspective (Rothman et al., 2007). However, the array of tools prevents any form of comparison of the findings documented by studies. This richness may be due to the generic intent of the studies, not being specifically aimed at measuring comfort, and to the gap regarding the gold standard in measuring comfort among these patients.

Secondly, under the conceptual point of view, tools have measured both comfort and discomfort, which are not the same. Discomfort is related to pain as an unpleasant psychological and physiological feeling resulting in a natural response of avoidance or reduction of the source of the discomfort (Ashkenazy & DeKeyser Ganz, 2019). Pain may trigger discomfort, but not every discomfort can be attributed to pain, as in the case of patients undergoing HFNC. Moreover six (42.9 %) tools were multi-items (with more than one question/item) in nature; multi-item or multidimensionality may better detect the whole comfort experience; however, responding to several items may also increase the burden of patients undergoing HFNC. The comfort should be assessed especially at the beginning of the treatment, to assess the progressive adaptation of the patient in a feasible manner also for patients. However, when comparing tools with one or more items, similar findings have been obtained, as emerged in correlational analysis (COMFORT-B scale vs VAS) and in the intraclass correlation coefficient analysis (COMFORT-B scale vs VAS vs NRS for satisfaction) (Valencia-Ramos et al., 2018), suggesting that mono-item tools may be recommended.

Thirdly, regarding the types of tools, among the unidimensional, the VAS was the most reported (e.g. Rittayamai et al., 2014), likely because it is widely used and validated to measure pain (Karcioglu et al., 2018). The NRS, validated to detect pain, has also been used in its visual and verbal form, which is more practical and easier to understand because it does not require clear vision, dexterity, paper, and pen (Breivik et al., 2008). A part of the different metrics used (e.g. 0–5, 0–10, 0–100) that may also prevent comparison, given that these tools are routinely used in assessing pain, patients may be confused when asked to assess their level of perceived comfort. Similarly, the Faces Scale has been widely used to assess pain in children (Garra et al., 2010), and its use to measure comfort (e.g. Tiruvoipati et al., 2010) may trigger confusion.

Among multi-item tools filled in by patients (e.g. Xu & Liu, 2021) or healthcare professionals (e.g. Bueno Campaña et al., 2014), fragmented evidence has emerged. The GCQ was the first tool developed to evaluate patient comfort holistically (Gonzalez-Baz et al., 2023); this multidimensional tool was used in one study (Xu & Liu, 2021). The validity of the Comfort Scale has been assessed only regarding the concordance between nurses and parents regarding the comfort experienced by neonates (Bueno Campaña et al., 2014). The tool was used also later (Sarkar et al., 2018), suggesting an attempt to cumulate evidence in the field. A modified version of the COMFORT scale was used in one study (Shah et al., 2021), using a tool validated for assessing distress among paediatric ICU patients (Ambuel et al., 1992) also suggesting an attempt to adapt and validate the tool in the context of HNFC. A similar case is seen for the PFSDQ (Liu et al., 2023) that was previously validated (Guo et al., 2010) to assess functional status and dyspnoea in chronic obstructive pulmonary disease patients but not their comfort. The COMFORT-B scale was used in two studies (Valencia-Ramos et al., 2018; Valencia-Ramos et al., 2019): this is a simplified version of the COMFORT scale (Ambuel et al., 1992) with two items fewer; it has been previously validated to measure stress (Carnevale & Razack, 2002). Not lastly, the EDIN tool was developed to assess pain among premature infants and its validation has not been concluded (Debillon et al., 2001).

Finally, some innovative approaches can be traced among those who have attempted to validate a new specific tool (e.g. Yuan et al., 2020), suggesting their aim to better capture comfort given the lack in the field, and those who have tried to simplify the measure by directly asking participants whether they perceived (or not) comfort (Nakanishi et al., 2020; Yilmazel Ucar et al., 2021). Overall, no studies have provided validation data of tools to measure comfort during HFNC. Existing tools validated to assess pain among adults (Frat et al., 2015) or paediatric patients (e.g. Tiruvoipati et al., 2010) have been used by replacing the term “pain” with “comfort” or “discomfort”. On the other hand, some authors developed ad hoc tools (e.g. Lucangelo et al., 2012), suggesting that properties should be further investigated in the future.

Limitations

This scoping review has several limitations. Firstly, although an inclusive approach was used and four databases were checked, some publications may have been missed. Secondly, despite efforts to check the references of the studies included data regarding validation of the tools used may have been missed. Furthermore, tool classification has not been addressed by the conceptual frameworks available in the field of comfort but inductively performed as the tools emerged. Future studies may address the same research question by categorizing the tools using a conceptual framework (e.g. Lorente et al., 2018), thus informing the comfort dimensions most investigated in the field.

Conclusions

Comfort among patients undergoing HFNC has been widely investigated to date. The body of evidence produced derives from small studies, mainly conducted in Europe and Asia, with comfort measurement as a secondary aim, and involving adults cared for in the ICU. A total of 25 tools have been used in the context of HFNC, grouped in 14 types, several adapted from tools measuring pain. Among those retrieved, only the GCQ and the Comfort Scale have been specifically validated for the assessment of comfort among adults and children, respectively.

It is recommended to develop and validate a tool evaluating the comfort among patients undergoing HFNC by following scientific sound methodologies and clarifying both conceptually and operationally if it is better to measure comfort or discomfort. In developing the tool, patient’s perceptions of flow and temperature – documented as mostly influencing the dryness or humidity of the nose and thus the comfort – should be considered. Moreover, patients outside the ICU, such as general wards and non-operating room anaesthesia settings (e.g. radiology, endoscopy units) should also be considered according to the increased use of the HFNC. To prevent any additional burden related to multiple items, future research should assess the capacity of unidimensional tools to measure comfort. According to the evidence produced, appropriate clinical recommendations should be included in clinical guidelines addressing the practice in the field.

CRediT authorship contribution statement

Alessandro Galazzi: Writing – original draft, Visualization, Investigation, Formal analysis, Data curation, Conceptualization. **Matteo Petrei:** Writing – original draft, Investigation, Formal analysis, Conceptualization. **Alvisa Palese:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iccn.2024.103719.

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