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Systematic Review

Beyond pneumoperitoneum: alternative and innovative uses of the Veress needle — a systematic review

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ABSTRACT

The Veress needle is a cornerstone of minimally invasive surgery. Originally developed to induce artificial pneumothorax for tuberculosis treatment, it is now primarily recognized for its role in creating pneumoperitoneum. The objective of this study was to systematically summarize the innovative, off-label applications of this device that extend beyond its conventional use in establishing pneumoperitoneum. In accordance with PRISMA 2020 guidelines, a systematic search was conducted on PubMed, Scopus and Cochrane Library databases to identify and categorize documented non-conventional applications of the Veress needle. Methodological quality was assessed using the Mixed Methods Appraisal Tool. A total of 54 studies met the inclusion criteria and were included in the qualitative synthesis. The included studies were categorized into four domains: surgical access and technical assistance, thoracic applications and emergency decompression, specialized diagnostic and therapeutic applications, and preclinical and experimental validation. Methodological quality was predominantly moderate (83%), with the majority of reports consisting of case series or case reports. To the best of our knowledge, this is the first systematic review highlighting how this nearly century-old invention has evolved into a versatile, multifunctional tool in modern minimally invasive surgery.

Keywords: Veress needle, Systematic review, Off-label use, Surgical innovation

INTRODUCTION

The Veress needle (VN) was developed in 1933 by János Veress, a Hungarian internist, primarily for the treatment of tuberculosis. Its original indication was to establish an artificial pneumothorax, thereby achieving pulmonary collapse to facilitate healing by resting the infected parenchyma. From the 1960s onward, with the widespread adoption of laparoscopy, its clinical application shifted toward the creation of pneumoperitoneum, eventually becoming the cornerstone for laparoscopic access.[1]

Owing to its simple yet robust design, global accessibility, and cost-effectiveness, the VN possesses significant innovative potential beyond its conventional role.

Consequently, a growing body of literature reports on leveraging these unique mechanical properties for various off-label, alternative, and minimally invasive applications. The objective of this systematic review is to comprehensively evaluate the innovative and off-label applications of the VN published in the literature to date.

METHODS

Search strategy

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.[2] The protocol was prospectively registered with PROSPERO (CRD420261404228). Although the original protocol specified searching MEDLINE, PubMed, and Scopus, the search was ultimately performed across PubMed, Scopus, and the Cochrane Library on May 24, 2026, to ensure a more comprehensive identification of clinical trials and evidence.

The search was limited to English-language publications regarding the off-label applications of the VN. The complete search strategy, including all Boolean operators and keywords utilized for each database, is provided in the Supplementary Material (Supplementary Appendix 1).

Eligibility criteria

Studies were included if they reported original data on the off-label use of the VN or devices derived from the VN mechanism for indications beyond conventional laparoscopic pneumoperitoneum creation. Eligible study designs encompassed original English-language research (including clinical trials, observational studies, case reports, and technical notes) involving human patients or animal models. To be selected, studies were required to report at least one of the following outcomes: technical feasibility, procedural success rate, safety, or procedure-related complications.

Conversely, studies were excluded if they focused exclusively on standard pneumoperitoneum creation, failed to explicitly identify the VN as the utilized instrument, or consisted of secondary research lacking original data (e.g., reviews, editorials, letters, and conference abstracts for which the full text was unavailable). Inclusion and exclusion criteria are summarized in Table 1.

Table 1: Eligibility criteria.

Category	Inclusion criteria	Exclusion criteria
Participants	Human patients (all ages) or animal models	Studies without biological/anatomical models
Intervention	Non-conventional or off-label applications of the Veress needle (or devices derived from its mechanism) as a primary or auxiliary tool	Standard laparoscopic pneumoperitoneum induction
Outcomes	Reporting of at least one metric: technical feasibility, procedural success rate, safety outcomes, or complications	Studies lacking specific data on procedural outcomes or safety
Study design	Peer-reviewed original research: clinical trials, cohort studies, case-control studies, case series, case reports, and technical notes	Secondary research (reviews, meta-analyses), editorials, letters, or conference abstracts without full-text access
Language	Full-text articles published in English	Articles published in languages other than English

Study selection

Initial deduplication was performed using Zotero reference management software (version 9.0.4), followed by manual verification. Two authors (Z.H. and K.B.P.) independently screened the titles and abstracts of all identified records. Subsequently, the full texts of potentially eligible reports were obtained and independently assessed for final inclusion. Discrepancies were resolved through discussion until consensus was reached. The complete selection workflow, including specific reasons for exclusion at the full-text stage, is illustrated in the PRISMA flow diagram (Figure).

Methodological quality assessment

To assess the risk of bias, two reviewers (Z.H. and K.B.P.) independently appraised the methodological quality of the included studies using the Mixed Methods Appraisal Tool (MMAT).[3] Following the MMAT guidelines, each study was first categorized by study design and subsequently evaluated against five specific quality criteria focused on methodological rigor, including selection bias, measurement validity, and data integrity. Any discrepancies in scoring were resolved through discussion until consensus was reached.

Data extraction

Relevant data from the included studies were extracted into a standardized data extraction form using Microsoft Excel. To ensure accuracy and consistency, the process was performed by one author (Z.H.) and cross-checked by a second author (K.B.P.). The data points recorded for each study encompassed the population or model used, sample size, the specific indication, and the procedure performed. Additionally, key outcomes and any reported

complications or safety data associated with the intervention were documented for final synthesis.

Data synthesis

Due to the observed heterogeneity in study designs, participant populations, and clinical indications, a formal meta-analysis was not feasible. Instead, a narrative synthesis was performed in accordance with the Synthesis Without Meta-analysis (SWiM) reporting guidelines.[4] Data were grouped and summarized according to the clinical indications for the off-label use of the VN. Results are presented descriptively and supported by summary tables. Where possible, a quantitative summary of key outcomes such as procedural success and the incidence of complications was provided to offer a structured overview of the evidence across the included literature.

RESULTS

Study selection

The initial electronic database search identified 677 records. After the removal of 51 duplicates, 626 unique records were screened based on their titles and abstracts, leading to the exclusion of 507 articles. The remaining 119 reports were sought for retrieval and underwent full-text assessment for eligibility. During this stage, 65 articles were excluded for the following reasons: 54 focused on standard indications rather than off-label applications, 9 utilized ineligible study designs, and the full text was unavailable for 2 reports. Ultimately, 54 studies met all inclusion criteria and were included in the final synthesis. The complete selection process and the flow of information are illustrated in the PRISMA flow diagram (Figure 1).

Study characteristics

The included studies were published over a 43-year period, spanning from 1983 to 2026. While early publications were sporadic, a steady upward trend in the volume of literature has been observed since the turn of the century. Notably, approximately one-third of the total cohort (35.19%; n=19) were published within the last decade, between 2016 and 2026. The earliest report, dating back to 1983, explored the utility of the VN for thoracocentesis, whereas the most recent publication in 2026 focused on controlled capnothorax induction to facilitate diaphragmatic resection. The geographical distribution of the 54 included studies reflects a widespread international interest in alternative VN applications. These studies originated from 22 unique countries across four continents. The Americas contributed the highest volume of publications (n=21; 38.89%), followed by Europe (n=19; 35.19%), with the USA (n=19; 35.19%) and Italy (n=5; 9.26%) being the most prominent individual contributors. Asia accounted for 24.07% (n=13) of the total cohort, led by research from India (n=4; 7.41%), while only a single study originated from the African continent.

A clear economic divide was observed between clinical and experimental applications. Notably, 27.78% (n=5) of the articles related to unconventional surgical access and technical innovations originated from low- and middle-income countries, whereas the vast majority (n = 18; 94.74%) of articles focusing on experimental studies, drug and substance delivery, and diagnostic applications originated from high-income countries. Across the 54 included studies, off-label interventions or experiments using the VN were performed on a total of 1,846 human patients, 141 animal models, 14 cadaveric models, and 16 ex vivo specimens. Sample sizes were not specified in one article, which focused solely on the technical description and feasibility of a novel procedure.

Regarding study designs, case reports and case series represented the largest portion of the literature (n=28; 51.85%). Observational and cohort studies, encompassing both prospective and retrospective comparative designs, accounted for 20.37% (n=11) of the included studies. High-level clinical and experimental evidence was identified in seven randomized controlled trials (n=7; 12.96%), representing the most robust study methodologies within the cohort. Finally, experimental research accounted for 14.81% (n=8) of the total cohort. Detailed characteristics of the included studies are presented in Supplementary Appendix 2.

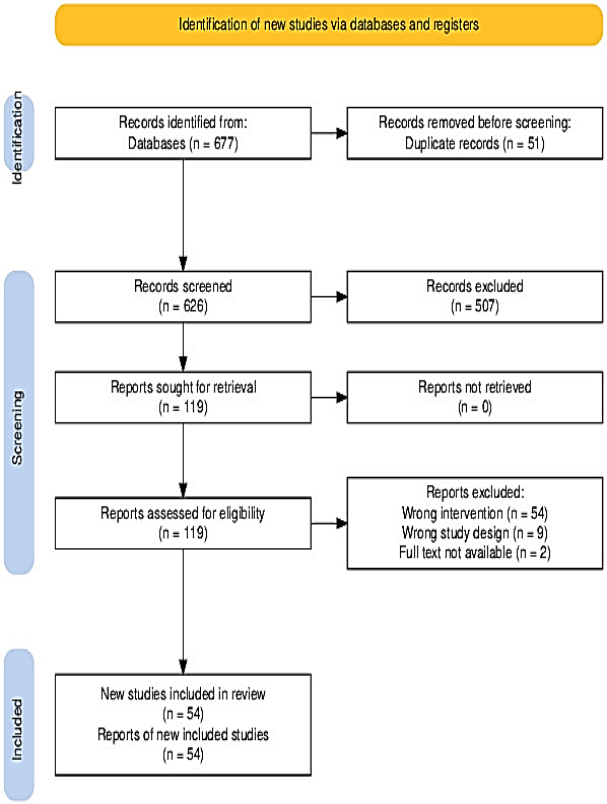

Figure 1: PRISMA 2020 flow diagram illustrating the study selection process.

Methodological quality assessment

Based on the MMAT, the cohort consisted of 36 quantitative descriptive studies (66.67%), 11 quantitative non-randomized studies (20.37%), and 7 quantitative randomized controlled trials (12.96%). The overall quality rating was found to be moderate for the majority of the literature (n=45; 83.33%), while high quality was identified in 8 studies (14.81%) and only 1 study (1.85%) was rated as low quality. On average, the studies met 3.72±0.74 of the 5 quality criteria. The methodological quality scores for each study are summarized in Table 2.

Clinical indications for off-label use

The identified literature revealed a broad spectrum of off-label applications for the VN, ranging from critical emergency interventions to novel diagnostic tools. To provide a structured synthesis, these reports were categorized into four primary functional domains.

Surgical access and technical assistance (n=18)

Within this category, the VN served as a versatile access and auxiliary tool. The device provided safe, non-traditional access to the pouch of Douglas for transvaginal procedures, as well as to the retroperitoneum for renal cyst ablation.[5-8] Its role as a conduit was particularly prominent in nephrology for the modified insertion of peritoneal dialysis catheters and in pediatric urology for successful antegrade or retrograde ureteral stenting.[9–15]

Furthermore, the VN functioned as a mechanical aid, serving as a simple liver retractor in bariatric and gastric procedures thereby obviating the need for additional trocars and as a temporary forceps port in hernia ligation.[16-18] The VN was utilized as an auxiliary needlescopic port to facilitate complex suturing during embryonic-natural orifice transluminal endoscopic surgery (E-NOTES).[19] Finally, the VN acted as a guide for intragastric port placement or fascial port-site closure.[20-22]

Table 2: Methodological quality assessment of the included studies.

Author	Year	Study design	MMAT criteria met	Overall quality rating
Alshiek et al[54]	2022	Quantitative descriptive	4/5	Moderate
Asif et al[9]	2004	Quantitative descriptive	4/5	Moderate
Babu et al[13]	2019	Quantitative non-randomized	4/5	Moderate
Bhansakarya et al[40]	2020	Quantitative descriptive	3/5	Moderate
Bishmanov et al[14]	2020	Quantitative descriptive	4/5	Moderate
Chandrasekharam et al[15]	2025	Quantitative descriptive	4/5	Moderate
Desai et al[19]	2009	Quantitative descriptive	3/5	Moderate
Ehrlich et al[37]	2007	Quantitative descriptive	3/5	Moderate
Ekwunife et al[41]	2012	Quantitative descriptive	3/5	Moderate
Ertekin et al[16]	2025	Quantitative non-randomized	5/5	High
Favelier et al[23]	2013	Quantitative descriptive	3/5	Moderate
Giampaolino et al[5]	2015	Quantitative descriptive	5/5	High
Gianni et al[17]	2012	Quantitative descriptive	2/5	Low
Gordts et al[7]	1998	Quantitative non-randomized	4/5	Moderate
Gordts et al[6]	2000	Quantitative non-randomized	5/5	High
Guarner-Argente et al[57]	2011	Quantitative descriptive	4/5	Moderate
Hendrickson et al[28]	2004	Quantitative descriptive	4/5	Moderate
Holcomb et al[46]	2009	Quantitative randomized	4/5	Moderate
Huan et al[27]	2025	Quantitative descriptive	4/5	Moderate
Iqbal et al[25]	2014	Quantitative descriptive	4/5	Moderate
Jaroszyński et al[10]	2024	Quantitative descriptive	4/5	Moderate
Jenkins et al[31]	1983	Quantitative non-randomized	4/5	Moderate
Johnson et al[30]	2018	Quantitative descriptive	3/5	Moderate
Kilincaslan et al[38]	2014	Quantitative descriptive	3/5	Moderate
Kotakala et al[21]	2015	Quantitative descriptive	3/5	Moderate
Kumthekar et al[53]	2023	Quantitative descriptive	3/5	Moderate
Kurian et al[32]	2013	Quantitative non-randomized	5/5	High
Leatherman et al[47]	2017	Quantitative randomized	4/5	Moderate
Leatherman et al[48]	2017	Quantitative randomized	4/5	Moderate
Leeds et al[20]	2015	Quantitative descriptive	3/5	Moderate
Lockhart et al[34]	1987	Quantitative descriptive	3/5	Moderate

Continued.

Author	Year	Study design	MMAT criteria met	Overall quality rating
Lubin et al[49]	2013	Quantitative randomized	4/5	Moderate
Lund et al[43]	2003	Quantitative descriptive	3/5	Moderate
Ma et al[11]	2021	Quantitative non-randomized	5/5	High
Maeda et al[24]	2022	Quantitative descriptive	3/5	Moderate
Marecos et al[51]	2006	Quantitative descriptive	4/5	Moderate
Mazzocchi et al[42]	2010	Quantitative descriptive	3/5	Moderate
McEvoy et al[50]	2018	Quantitative randomized	4/5	Moderate
Meining et al[55]	2007	Quantitative descriptive	4/5	Moderate
Menczer et al[44]	1995	Quantitative descriptive	3/5	Moderate
Morozov et al[58]	2023	Quantitative non-randomized	4/5	Moderate
Napoli et al[12]	2000	Quantitative non-randomized	4/5	Moderate
Nau et al[36]	2010	Quantitative descriptive	4/5	Moderate
Pfeiffer et al[45]	1989	Quantitative descriptive	3/5	Moderate
Ranjani et al[22]	2026	Quantitative randomized	3/5	Moderate
Rathinam et al[33]	2014	Quantitative descriptive	3/5	Moderate
Sabatella et al[26]	2026	Quantitative descriptive	4/5	Moderate
Saunders et al[35]	1998	Quantitative randomized	5/5	High
Seshadri et al[39]	2000	Quantitative non-randomized	3/5	Moderate
Sharata et al[52]	2014	Quantitative descriptive	3/5	Moderate
Soldati et al[29]	2013	Quantitative descriptive	5/5	High
Sühn et al[56]	2020	Quantitative descriptive	3/5	Moderate
Tatekawa et al[18]	2012	Quantitative descriptive	4/5	Moderate
Zhang et al[8]	2012	Quantitative non-randomized	5/5	High

Thoracic and emergency interventions (n=11)

A subset of reports highlighted the induction of an artificial pneumothorax to prevent iatrogenic lung injury during transthoracic adrenal biopsies, renal cryoablation, and coil localization of lung nodules, as well as to facilitate diaphragmatic resection.[23-26] Similarly, in the absence of significant pleural effusion, the VN was employed to create a safe pleural space to ensure the safety of thoracoscopic procedures.[27]

In the management of pleural collections, the VN served as a safe tool for bedside thoracentesis and pigtail catheter insertion, even in non-traditional patient positions.[28,29] Crucially, the device was identified as an emergency rescue tool for the immediate decompression of life-threatening tension states, including tension pneumoperitoneum following resuscitation and intraoperative capnothorax or capnoperitoneum during complex endoscopic procedures.[30-33]

Specialized diagnostic and therapeutic applications (n=12)

In this category, the VN was utilized for percutaneous peritoneal lavage in blunt trauma patients and for transfascial intraabdominal pressure monitoring to validate endoscopic insufflation.[34-36] Furthermore, the device was successfully employed for the atraumatic aspiration and drainage of various fluid collections, including large ovarian, splenic, and paratubal cysts, as well as hepatic abscesses and periprosthetic seromas in patients with breast implants.[37-42]

In these procedures, the needle's safety mechanism was critical for preventing fluid spillage and protecting adjacent anatomic structures or implants from accidental injury. As a delivery system, the VN enabled the precise injection of bulking agents (e.g., Teflon) into the bladder neck to restore continence in pediatric patients.[43] Additionally, it provided a safe and cost-effective conduit for the intraperitoneal administration of chemotherapy, offering a reliable single-use alternative to permanent indwelling catheters.[44,45]

Experimental and preclinical studies (n=13)

Preclinical research utilizing animal and cadaveric models primarily focused on optimizing emergency trauma care. These investigations demonstrated that modified VN-based devices offer superior safety and efficacy for thoracic decompression compared to standard catheters.[46-50] The Veress needle was used to establish pleural access for the induction of experimental empyema in an animal training model.[51] Furthermore, the VN's utility was validated for minimally invasive access and assistance across various experimental settings. In cadaveric and animal models, the VN served as a lateral neck retractor to enhance visualization during subxyphoid thyroid lobectomy and as an initial percutaneous tool to reach the pericardial space for epicardial pacemaker lead implantation.[52,53]

Additionally, preclinical studies validated the VN for confirming the localization of the pouch of Douglas and acting as a conduit for auxiliary instrumentation during NOTES cholecystectomy, thereby obviating the need for standard trocars.[54,55] Innovative applications also extended to diagnostic monitoring and device development. The VN was successfully used as an acoustic palpation probe for cartilage characterization and for intra-peritoneal pressure monitoring to verify the seal integrity of gastric closures.[56,57] Finally, the core mechanism of the VN has inspired the development of novel needle designs that leverage the spring-loaded safety-feature to minimize tissue trauma during renal puncture.[58]

Procedural success and safety outcomes

Surgical access and technical assistance

Regarding specialized access, VN-assisted transvaginal hydrolaparoscopy under local anaesthesia was demonstrated to be a feasible outpatient procedure, although rare complications including haematoma and rectal perforation were identified.[5-7] For retroperitoneal working space creation, the technique facilitated successful laparoscopic completion without conversion, achieving a lower incidence of subcutaneous emphysema and CO2 leakage.[8] In the fields of nephrology and paediatric urology, a 100% technical success rate was reached in peritoneal dialysis catheter insertions, while VN-guided stenting proved significantly more efficient than conventional methods.[9-15] Furthermore, the VN served as a highly effective tool for liver retraction; its application obviated the need for additional ports, leading to significantly lower postoperative liver enzyme elevations and reduced pain.[16-17] In emergency and reconstructive settings, VN-guided intragastric port placement was successfully performed without VN-related complications.[20]

Similarly, the VN was effectively utilized as an auxiliary forceps port during laparoscopic inguinal hernia ligation, with no recurrences or complications reported during the follow-up period.[18] In complex E-NOTES urological reconstructions, the needle further facilitated reconstructive maneuvers and allowed for the avoidance of additional ports without VN-related adverse events.[19] Finally, utilizing the VN for port site closure demonstrated a 100% technical success rate and significant cost-effectiveness, while reducing closure times, postoperative pain, and rates of infection or dehiscence.[21-22]

Thoracic applications and emergency decompression

The VN yielded high technical success and a superior safety profile across thoracic and emergency applications. In pleural access procedures, success rates ranged from 80.6% to 100%, with comparative evidence indicating significantly lower complication rates than conventional techniques. Notably, VN-guided procedures achieved a 96.7% primary therapeutic success rate in paediatric bedside thoracostomies (STEP-TT) and 100% feasibility in US-guided pleural punctures.[28,29] In emergency settings, the VN proved to be a reliable tool for rapid decompression. Technical success was achieved in all cases of emergency abdominal and thoracic decompression.[30-32]

In specialized surgical settings, the VN enabled precise nodule localization for VATS resections and provided effective lung protection via artificial pneumothorax induction.[23-25,27] In advanced oncological cases, VN-assisted laparoscopic liver and diaphragmatic resections were feasible.[26] Additionally, the needle was successfully utilized for pleural effusion drainage, achieving 100% resolution.[33] Across this group, complications remained minimal, with only rare instances of pneumothorax (1.4%) or procedural error reported.

Specialized diagnostic and therapeutic applications

The VN exhibited remarkable clinical versatility within specialized diagnostic and therapeutic settings. The device facilitated the successful decompression and aspiration of ovarian, splenic and paratubal cysts, as well as liver abscesses, consistently achieving technical success while notably ensuring the complete prevention of intraperitoneal spillage.[37-41] In diagnostic applications, such as peritoneal lavage, the VN demonstrated absolute reliability and was significantly faster than open techniques.[34,35]

Further diagnostic utility was evident in US-guided periprosthetic fluid aspiration and intra-abdominal pressure monitoring during transgastric NOTES, where VN-derived values correlated precisely with endoscopic measurements.[42,36] Regarding therapeutic interventions, the VN provided a safe and cost-effective conduit for repeated intraperitoneal chemotherapy delivery, with success rates reaching up to 100%.[44,45] These procedures were associated with only minimal morbidity notably a 2.3% minor complication rate and no major injuries. Furthermore, the instrument was effectively utilized for periurethral Teflon injection in paediatric patients with neurogenic bladder, resulting in total continence.[43]

Experimental and preclinical validation

Preclinical studies confirmed the VN's robustness and versatility, with success rates generally ranging between 85% and 100%. Technical success was demonstrated in complex procedures, including robotic vNOTES, transsigmoid NOTES and subxiphoid thyroidectomy.[54,55,52] Furthermore, modified VN (mVN) reduced procedural trauma during percutaneous renal access procedures compared to standard devices.[58] In emergency models, the VN outperformed conventional decompression tools, achieving 100% success in tension

pneumothorax models versus 21% with standard needles.[46-50]

Despite demonstrating superior procedural efficiency and resuscitation efficacy, a performance threshold of 57% was identified in extreme pulseless electrical activity models, where larger-bore instruments proved more effective.[53] Finally, the VN proved effective in training models achieving 85% success in empyema induction and diagnostic applications like cartilage grading.[51,56] These interventions remained safe across all settings, further underscoring the instrument's mechanical stability and safety. The VN was feasibly and effectively used to monitor intraperitoneal pressure during gastrostomy closure.[57]

DISCUSSION

Historical timeline and technological evolution

The evolutionary trajectory of the VN underscores a remarkable transition from a single-purpose tool to a versatile surgical accessory, capable of overcoming complex technical challenges in both resource-limited and high-tech environments. Early off-label reports emerged in the 1980s, as the VN began to transcend its primary role as a pneumoperitoneum insufflation device. This shift was partially driven by safety concerns associated with traditional blind abdominal entry, which carries inherent risks of visceral injury and haemorrhage. During this period, it was primarily utilized as a catheter for diagnostic peritoneal lavage, pleural fluid aspiration, and intraperitoneal chemotherapy delivery.[34,35,44,45] From the 2000s, driven by the global advancement of minimally invasive surgery, the VN gained prominence as a reliable decompression tool in emergency settings and served as an essential auxiliary instrument during early NOTES procedures.[30-32,19,36] Notably, within the past six years, the VN has been successfully integrated into advanced robotic-assisted procedures, advanced oncological resections and high-precision diagnostic modalities, such as acoustic cartilage palpation.[26,54,56] Crucially, the traditionally risky blind insertion has been increasingly superseded by visual-guided laparoscopic applications, as well as innovative ultrasound-guided and acoustic emission-based sensing techniques.

Geographical and economic disparities

Beyond its chronological evolution, the clinical application of the VN also exhibits distinct geographical disparities. Specifically, low and middle-income countries effectively leverage the device's simplicity and cost-effectiveness to overcome resource limitations in routine surgical practice. In these settings, the VN is utilized to manage complex tasks that would otherwise require expensive, more-sophisticated instrumentation, including ureteral stenting, aspiration of hepatic abscesses, and port site closure.[13-16,41,21,22] In contrast, high-income nations primarily focus on pre-clinical research and high-tech diagnostic and therapeutic innovations, such as osteoarthritic cartilage grading, the advancement of robotic and laparoscopic NOTES, intraperitoneal chemotherapy delivery, and percutaneous epicardial pacing lead placement.[56,54,44,45,53]

Procedural success and technical efficiency

Across the evaluated domains, off-label applications of the VN demonstrated high procedural success rates. Its spring-loaded mechanism and thin profile provide tactile feedback, enabling precise access during procedures such as transvaginal hydrolaparoscopy without extensive tissue dissection.[5-7] Furthermore, the VN has been effectively used for ultrasound-guided aspiration of fluid collections, cysts, and abscesses, ensuring accurate access while potentially minimizing the risk of intraperitoneal spillage.[37-41] The VN facilites various surgical procedures and may reduce procedural time in applications such as port-site closure and ureteral stenting in pediatric urology.[13-15,22] It can also serve as an auxiliary port to simplify complex suturing during natural orifice transluminal endoscopic surgery (NOTES).[19] Several studies have clearly demonstrated that, in patients with blunt abdominal trauma, diagnostic peritoneal lavage performed using a VN is significantly faster than the open technique while maintaining comparable diagnostic efficacy.34,35

Complication rates and safety profile

Conventional blind VN insertion during laparoscopic access has historically been associated with the risk of visceral and vascular injuries. In contrast, the reviewed studies describe a range of off-label applications in which the VN may offer procedural safety advantages. However, differences in clinical settings, techniques, and study designs limit direct comparisons of complication rates across these applications. In thoracic or abdominal emergency procedures, VN-based techniques have been used to achieve controlled decompression with limited tissue trauma.

These techniques may offer an alternative to conventional chest tubes or large-bore needles in selected clinical settings.[33,46–50] As a conduit, the VN provides a novel access technique for peritoneal dialysis catheter insertion, significantly reducing the overall complication rate and the risk of catheter migration.[9-12] When used as a simple retractor or temporary access port in gastrointestinal and inguinal procedures, the VN may reduce the need for additional trocars and thereby potentially minimize tissue trauma, postoperative pain, and analgesic requirements.[16-18]

Furthermore, VN-mediated induction of artificial pneumothorax and creation of a retroperitoneal working space facilitate thoracoscopic and laparoscopic procedures by improving access to the target area and reducing the risk of iatrogenic organ injury. These

applications include transthoracic adrenal biopsy, laparoscopic liver and diaphragmatic resection, pulmonary nodule localization, and laparoscopic renal surgery.[23-26,8]

Cost-effectiveness

The reviewed literature suggests that the VN may represent a low-cost, readily available option for selected procedures, potentially reducing the need for specialized equipment. Reported applications include port-site closure, use as a delivery conduit for intraperitoneal chemotherapy, intravesical administration of bulking agents, and as a drainage device for liver abscesses.[21,22, 41,43-45]

Limitations

Several limitations should be considered when interpreting the findings of this review. First, the included studies displayed substantial heterogeneity in terms of study design, patient population, clinical indications, and outcome measures, which impeded any meaningful meta-analysis across most applications. Second, the evidence base was predominantly composed of case reports, case series, and small observational studies, thereby limiting the strength of conclusions regarding comparative efficacy and safety. Finally, another key limitation lies in the methodological quality of the included literature, with 83% of the analysed reports classified as 'moderate' quality. Consequently, there is a clear need for higher-level evidence particularly randomized controlled trials to validate these innovative applications and establish definitive clinical guidelines.

CONCLUSION

Consequently, the VN facilitates various complex procedures even in resource-limited settings or under-equipped facilities and serves as a multifunctional therapeutic and diagnostic tool, as well as an indispensable tool in emergency scenarios. Given the remarkably low complication rates associated with its off-label use, the VN represents a highly promising instrument with significant untapped clinical potential.

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