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Research Article

Facilitators and barriers to evidence-based practice in central venous access device insertion and management in an intensive care unit: A qualitative study

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ABSTRACT

Introduction: Research evidence and clinical practice guidelines exist on preventing central line-associated bloodstream infections. However, there is limited knowledge about the barriers and facilitators to evidence-based central venous access device care.

Aim: The aim of this study was to investigate the facilitators and barriers to evidence-based central venous access device care in the adult intensive care setting.

Method: This exploratory qualitative study involved focus groups and interviews with registered nurses and physicians involved in central venous access device insertion and management in a tertiary Australian intensive care unit. Purposive sampling was used to recruit staff (n = 26) with varying years of clinical experience and clinical positions. Six focus groups and three individual interviews were conducted. Interviews were audio recorded, transcribed verbatim and analysed using content analysis.

Results: Three overarching categories emerged: work structures to support optimal performance; processes to optimise quality of care, and factors influencing staff members' behaviour. Perceived facilitators to optimal central venous access device care included explicit language use in procedure documents, work-system integrated strategies, research evidence dissemination, audit, and feedback. However, there was a lack of consistency in practices such as audit, feedback, and patient participation.

Conclusion: To bring about effective improvement in central venous access device care, future interventions should be tailored to address identified barriers, including integrating audit and feedback into clinicians' work processes. Additionally, future research is needed to explore the role of patients and their families in central venous access device care.

Implications for clinical practice: When developing practice policies or procedure manuals, it is important to use explicit language to ensure clear communication of evidence-based recommendations to clinicians. Strategies integrated into work processes can enhance adherence to evidence-based practice. Large departments with limited educators should explore innovative methods like online education to ensure optimal central venous access device care.

Introduction

Many critically ill patients require a central venous access device (CVAD), commonly referred to as a central line, for medication administration and monitoring. Types of CVAD commonly used in the adult intensive care setting include tunnelled central venous catheters (CVCs), peripherally inserted central catheters (PICC), and totally implantable devices (Centers for Disease Control and Prevention (CDC), 2015). Due to the invasive nature of its insertion, frequent access requirements, ongoing management, and the vulnerable or immune-compromised

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state of patients, central line associated blood stream infections (CLABSI) can occur. CLABSI, defined as an infection unrelated to any other source, occurring within 48 h of CVAD placement (Centers for Disease Control and Prevention (CDC), 2015), differs from catheter-related bloodstream infections (CRBSI) with CLABSI used for surveillance purposes and CRBSI being a clinical definition used to diagnose and treat patients with a pathological diagnosis required (Centers for Disease Control and Prevention (CDC), 2015). CLABSIs contribute significantly to morbidity and impose substantial costs to the healthcare system (Halton et al., 2010), but they are largely preventable (O'Grady et al., 2011b).

Current clinical practice guidelines (CPG) from professional organisations recommend the implementation of CVAD care bundles (Brescia et al., 2023, Buetti et al., 2022) to prevent CLABSI (Australian and New Zealand Intensive Care Society, 2012; Loveday et al., 2014; National Health Medical Research Council, 2010; O'Grady et al., 2011a). Elements of CVAD care bundles encompass proper hand hygiene, employing maximum sterile barrier precautions during CVAD insertion, using chlorhexidine as skin disinfectant, avoiding the femoral site, promptly removing the CVAD (Pronovost et al., 2006), using aseptic technique accessing and maintaining the catheters and insertion sites, and fluid administration (Duffy et al., 2015). These measures have proven effective in reducing CLABSIs, as indicated by a systematic review with meta-analysis (Ista et al., 2016).

There has been a decline in the incidence of CLABSIs in many countries due to heightened awareness of the consequences of CLABSI, increased surveillance, the increased adoption of recommendations from evidence-based CPG such as the use of care bundles (Ray-Barruel et al., 2019) and the use of medication impregnated dressings (Timsit et al., 2012). Nonetheless, CLABSI continues to occur in hospitals, with an estimated 0.46 cases per 1000-line days annually in Australia (Australia and New Zealand Intensive Care Society, 2020). Barriers and facilitators to evidence-based practice in CVAD insertion (Cameron et al., 2021), and management in the acute care setting (Harlan et al., 2022), have been reported in the literature, however, to our knowledge, limited information is available regarding the challenges and supports for evidence-based practice in CVAD post-insertion management un the UCU setting.

Aim

This study was prompted by an increase of CLABSI cases in the ICU which was higher than the ANZICS benchmark of 1/1000 line days (ANZICS Centre for Outcome and Resource Evaluation (CORE), 2014). Following a clinical audit of current practices in CVAD insertion and management in this setting (Lin et al., 2022), we undertook this study with the aim of identifying the barriers and facilitators influencing adherence to evidence-based clinical practice guidelines the insertion and care of CVADS in critically ill adult patients in the ICU. The findings from this study will guide the development of interventions and implementation strategies to be integrated into work processes to optimise the care of patients with CVADs.

Method

This qualitative exploratory study employed focus group and individual interview techniques for data collection. The methodology of this study and reporting were devised per the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong et al., 2007).

Theoretical framework

The refined theoretical domains framework (TDF) (Cane et al., 2012; Michie et al., 2005) guided the data collection and data analysis. TDF has been formulated from synthesising multiple sociology and behaviour change theories and frameworks following rigorous validation processes by a group of experts, which maps the determinants of behaviour change into 14 domains and 84 constructs, including aspects of knowledge, skills, social/professional role and identity, beliefs about capabilities, optimist, reinforcement, intentions, goals, memory, attention and decision processes, environmental context and resources, social influences, emotion, and behavioural regulation. These domains guided the development of the interview questions, in conjunction with the findings of the previous audit, to understand the barriers and facilitators to implementing best research evidence in CLABSI prevention.

Study setting

This study was conducted in a 22-bed adult ICU within a 750-bed Australian tertiary hospital. The ICU provides comprehensive intensive care services except for patients with burns, spinal injury, or who had undergone organ transplantation.

Sample

Purposive sampling was used to recruit a mixture of staff in terms of profession and years of clinical experience. Any ICU Registered Nurse (RN) or physician, including those in full-time, part-time, or casual positions, involved in CVAD insertion and management, who were available on the days data collection occurred, were eligible to participate. Focus groups were conducted with beside RNs and medical staff, while individual interviews were conducted with senior RNs who were in leadership roles and senior physicians, because the total number of staff in these roles were small. Junior medical staff working in the unit at the time were not invited to participate, as most of them were rotating through the ICU and had limited involvement in CVAD insertion. In this research, CVAD included centrally inserted central catheter (CICC), and femorally inserted central catheter (FICC).

Data collection

The focus groups and individual interviews were conducted over a 2-month period in late 2017. An open-ended interview guide, underpinned by the TDF theoretical framework (Cane et al., 2012) and informed by the previous clinical audit findings (Lin et al., 2022), was used to undertake the interviews. Example questions included (1) queries related to staff members' *knowledge* (TDF domain) on CVAD dressing change (e.g. "can you tell me when CVAD dressings should be changed?"), and its importance (e.g. "why do you think it is important to change the dressing at this time"?); (2) questions related to the TDF *procedural knowledge*, and *skills* domain (e.g. "how do you clean the access ports of CVCs" and "what technique do you use when cleaning them"?); and (3) Questions explored both barriers and facilitators (covering concepts in the TDF domains such as *beliefs about capabilities*, *environmental context and resources* etc), with a focus on areas needing improvement based on our previous audit findings (e.g. "what makes it difficult to do …" and "what makes it easy for you to do …"). Further, preliminary data analysis, which occurred simultaneously during the data collection and is as a key feature of qualitative research (Denzin and Lincoln, 2011), informed the ongoing revision of interview questions during data collection. Staff members' demographic data, including age, gender, years of education, years of experience, and clinical position, were also collected.

The focus groups, which occurred during office hours (8 am–5 pm) from Monday to Friday, were held if staffing levels in the ICU allowed for at least four staff to leave the unit for up to an hour. The one-on-one interviews were conducted with senior staff at a mutually agreed time. The first author, an experienced PhD qualified qualitative researcher who did not have a direct working relationship with the participants, conducted all individual interviews and focus groups. Further, a research assistant attended the focus groups to observe and take notes. Initially, twenty participants were anticipated to be interviewed based

on previous studies of a similar design (Lin et al., 2020a); however, focus groups and interviews continued until data saturation was reached (i.e., no new information was identified) (Denzin and Lincoln, 2011). This occurred after the fifth focus group; however, an additional focus group was held to confirm that data saturation had, indeed, occurred. Notes were also taken during individual interviews. Focus groups lasted about 60 min, and individual interviews lasted about 30 min. All interviews were audio recorded and transcribed verbatim.

Data analysis

Descriptive data analysis, including absolute and relative frequencies, were used for categorical demographic data. Median and interquartile range (IQR) were used for all continuous data as they were not normally distributed. Nvivo (Version 20, QSR International) was used to manage the qualitative data analysis. A combination of deductive and inductive content analysis was used to identify categories and subcategories. First, a deductive approach was used using the headings of the recommended strategies in current CPGs as labels/categories. Next, inductive qualitative data analysis was undertaken to identify overarching categories across the initial categories. Barriers and facilitators were identified within the overarching categories using a deductive analysis approach. The first author analysed the data, and the team reviewed and gave feedback. Revisions were made accordingly.

Ethical considerations

Ethics approval was granted by the hospital (GCHHS HREC/16/QGC/4) and the university (No. 2016/399). All participants were asked to sign a consent form after having read the participant information sheet. Participant demographic data was summarised as group data to protect their privacy.

Findings

A total of 26 participants took part in this study, consisting of 22 nursing staff and 4 medical staff. This number represented approximately 13% of the 165 nurses and 33% of the 12 ICU medical staff members qualified to insert CVADs working in the ICU at the time of data collection. Of the participants, three staff, including one senior RN and two physicians participated in individual interviews, while the remaining staff members (21 RNs and 2 physicians) participated in one of the six focus groups. Each focus groups consisted of 3–5 staff members due to staffing constraints on the data collection days. Staffs' demographic data are shown in Table 1.

Table 1
Participants demographic data.

	Median (n)	**IQR**
Age (years)	36	28–48
Work experience in ICU (years)	3	2–6
	Number (n)	**Percentage (%)**
Sex		
Female	20	76.9
Male	6	23.1
Employment classification		
Physicians	4	15.4
Registered Nurses	22	84.6
Total	*26*	*100%*
Professional qualification		
Bachelor degree	12	46.2
Graduate certificate	6	23.1
Master	8	30.8
Total	*26*	*100%*
Employment status		
Full time	18	69.2
Part time	8	30.8
Total	*26*	*100%*

Qualitative data analysis revealed three overarching categories: (1) work structures to support optimal performance, (2) processes to optimise quality of care, and (3) factors influencing staff members' behaviour. In Table 2, we present the categories, the facilitators and barriers within each category in relation to TDF domains. In the following section, FG# denotes the sequence number of the focus group, and INT# denotes the sequence number of the interview.

Category 1: Work structures to support optimal performance

This category describes the organisational structures at the ICU level, including the ICU CVAD insertion and management policy (referred to as CVAD policy hereafter), documentation, the quality and safety staff role, and education that facilitated or hindered evidence-based practice as perceived by the participants.

In relation to the CVAD policy, participants reported that while some aspects of the CVAD care, such as how to manage parenteral nutrition infusions via CVADs, were clearly stated in the ICU CVAD policy, more explicit recommendations for CVAD care in the local policy were needed. The following statement is a typical example of what participants said:

> "*It* [the ICU CVC management policy] *just says that we need to apply aseptic technique* [when cleaning the CVC access ports]*, but it doesn't actually tell you how to do it, and how long you have to clean it for.*" (FG 1. Similar statement in FG5).

When asked about CVAD care documentation, staff perceived that reminders on the electronic system were instrumental in CVAD care compliance:

> " … *I think if you build it in* [the electronic work system]*, it'll automatically come up as a reminder*". (FG1)
>
> *"… it's* [the task to flush unused CVC access port] *actually in the nursing work list* [on the computer]. *It comes up with a prompt in that tab to flush a central line and other things*." (FG1)

Participants agreed that the ICU's safety culture, having dedicated staff to lead the quality and safety agenda in the ICU, and particularly, having medical and nursing staff dedicated to driving the CLABSI prevention agenda in the ICU, was important to promote evidence-based practice. This was mentioned often in the focus groups as an effective way to keep staff up to date with new research evidence on CVAD care.

Education was mentioned frequently. The comprehensive ICU orientation program for new staff was identified as a facilitator, which was said to "*teach staff the right way to do certain things from the start*", and "*hard-wire the information into our brain*". Ongoing educational programs and the annual clinical competency assessments were some of the key influential factors for good compliance with recommended practices in CVAD care. The ratio between the number of educators and number of nurses employed in the ICU was mentioned several times by senior staff as a barrier to staff education regarding CVAD management. The ICU had a rapid expansion in the number of beds and staff in recent years. It was acknowledged that education for all staff had been challenging with limited number of educators employed. As this quote from a focus group attended by senior nurses illustrated:

> "*We teach them* [bed side RNs]*… but you certainly can't get around over 200* [nursing] *staff when you've got such huge* [number of] *staff coming through. You do the best you can. … I think it's also how you can communicate with all staff, because not everyone's on the emails – you're not going to get everyone in the huddle* [a quick team communication activity]. *You'd probably see 50% of the staff.*" (FG4)

Category 2: Processes to optimise quality of care

This category describes the facilitators and barriers to evidence-based practice related to CVAD care processes as perceived by the participants. Staff members perceived that several factors promoted adherence to unit protocols, including CVAD management. These factors

Table 2
Categories from data analysis.

Themes	Sub themes	Facilitator	Barrier	TDF# domains
Work structures to support optimal performance	The ICU CVC insertion and management policy	Clear language used in some aspects of the policy	Unclear message about aseptic technique in CVC policy	Environmental context
	Documentation	Reminders on the electronic system		Environmental context Memory, attentionReinforcement
	Leadership role and safety culture	Dedicated roles leading CLABSI *prevention		Environmental context
	Education program and competency assessment	Thorough orientation programs and regular staff competency assessments	Not enough educators to run education sessions and assess competency of all staff	Environmental context/ Skills
Processes to optimise quality of care	Integrating recommended practice into work routine	Audit and feedback; disseminating research evidence, demonstrations, role modelling by senior staff; safety checks at beginning of shift	Lack of consistency in audit and feedback, research evidence dissemination, and role modelling which only happened occasionally	Social influences Reinforcement Behavioural regulation
Factors influencing staff members' behaviour	Knowledge	Awareness of new research evidence;aware of the consequences of CLABSI; frequency of practice in certain tasks	Knowledge of the electronic system, Not being able to find where to document on the electronic system; did not know how to read CVC depth at skin and how long the access ports should be cleaned for; unclear about the benefits of using medication impregnated dressings to prevent CLABSI*	knowledge of task environment SkillsBeliefs about consequences
	Application of knowledge into practice		Aseptic technique: unclear about how to do it (such as cleaning the CVC access port for 15 s)	Procedural knowledgeSkills
	Perception		Believe some tasks being more important than others; not educating patients because CVCs are too complex for patients to understand or to be involved; not wearing hats and masks when assisting CVC insertion because "we are not close enough to the aseptic field"	Beliefs

Theoretical domains framework (Cane et al., 2012) *Central line associated blood stream infections.

included routine practices, such as safety check at the beginning of each shift and incorporating actions into daily routines. Additionally, random audits and reminders were utilised to ensure that staff followed recommended practices, and demonstrations and role modelling from senior staff played a crucial role in reinforcing adherence to protocols:

> "*I think also there's the Clinical Nurse Consultant role. Because they're sort of clinical champions, quality champions and they're out on the floor demonstrating that and checking up and following up, role modelling.*" (FG2)

Senior staff members also emphasised the importance of these work processes:

> "*Well because even just changing the guideline is not going to fix it* [the recent increase of CLABSI rates in the ICU]. *It will be education and promotion and then audit of their compliance again and continual reminders and again, making it something that's just expected.*" (INT1)

One barrier identified through the interviews was the lack of consistency in promoting and disseminating research evidence related to CVAD care. Although most participants were aware of the existence of the ICU CVAD policy, many were not familiar with some of the recommendations. Furthermore, while many participants acknowledged ad hoc research evidence sharing, where senior staff shared research findings in an unplanned manner and mentioned the occurrence of audits and feedback related to CVAD care in the ICU, it was clear that more efforts were required to promote evidence-based CVAD care. To address this issue, it was widely agreed among the participants that senior staff should promote evidence-based CVAD care more regularly, and conduct more frequent and regular audits and provide feedback on their practice in CVAD management.

Category 3: Factors influencing staff members' behaviour

This category describes staff members' perceptions of factors that influenced their behaviour in evidence-based practice in CVAD care. When participants were asked what helped them achieve high compliance levels on some items, such as giving patients baths using chlorhexidine as recommended in CPGs (Australian and New Zealand Intensive Care Society, 2012, Loveday et al., 2014), they stated that awareness of the current research evidence served as a motivator for adhering to the CPG recommendations.

However, several factors acted as barriers, limiting adherence to evidence-based practice in CVAD insertion and management. The data revealed differences in staff perception for the same task in various situations. For example, flushing the spare CVAD access ports, cleaning it for 15 s and waiting for them to dry were not seen as important as cleaning the access ports before and after giving medication, even though the actual cleaning tasks were the same. Time constraints, being frequently "*in a hurry*" and facing "*emergency situations*" were some of the reasons provided by participants for low compliance with cleaning the spare CVAD ports. Moreover, there were misconceptions among participants regarding the necessity of wearing masks and hats while assisting with CVAD insertions. Some participants believed that since they were "*not close enough to the aseptic field*", such precautions were unnecessary, contributing to a lack of adherence.

Another notable barrier was the staff members' knowledge deficits on various aspects, including reading CVAD catheter markings (depth at the insertion site), determining the appropriate duration for cleaning CVAD access ports, and staying updated on the latest research concerning medication-impregnated dressings for CLABSI prevention. This lack of knowledge was frequently mentioned during focus groups and interviews, with participants expressing difficulties locating CVAD documentation in the electronic system.

> "*If it's not getting told and you wouldn't know where to find it* [where to document CVC depth at the skin], [and] *where to look. Metavision* [electronic medical record system] *can be very confusing for a lot of things that change constantly.*" (FG5)

Involving patients in CVAD care was explored in our interviews as a strategy that could help promote guideline adherence. The consensus among clinicians was that patients and their family members had limited involvement due to several reasons. Firstly, patient acuity was a factor, as many patients were too ill to actively participate in their CVAD care. Secondly, the complexity of CVADs made it challenging for patients to fully comprehend and engage in their care. Lastly, the presence of patients' family members during their stay in the ICU was often limited, further restricting their involvement in CVAD management.

Discussion

Data analysis revealed three overarching categories related to organisational structures, work processes, and factors influencing staff behaviour in CVAD care within this ICU setting. In this study setting, structures (which is within the *environmental context* domain in the TDF framework (Cane et al., 2012)) such as nursing worklists and reminders on the electronic medical record system, safety culture, and dedicated staff leading patient safety efforts were perceived as facilitators to adhering to evidence-based practice. These findings align with existing literature highlighting effective strategies for improving clinical practice, such as dedicated roles driving the practice improvement (Loudet et al., 2017), work system reminders (Donovan et al., 2016), and education (Lin et al., 2020b). However, it is important to note that these structures could become barriers if not implemented effectively. Poor organisational infrastructure, particularly in terms of human resources, has been linked to subpar performance and challenges in care quality improvement (Vaughn et al., 2019). Within the current study, the large number of staff working in the department posed a challenge for the limited number of educators to provide comprehensive face to face education to everyone. This calls for a review of education program delivery and consideration of using innovative approaches like online simulation (Carman et al., 2017; Coyne et al., 2021; Lin et al., 2016) to enhance staff education reach in the ICU.

Regarding the language used in the ICU CVAD policy (which is also within the *environmental context* domain in the TDF framework), participants within the current study indicated a need for more explicit recommendations, particularly in terms of aseptic technique, to enhance its utility in CLABSI prevention. This adds evidence to the literature that implementing evidence based CPGs without contextual adaptation in complex settings such as ICUs often negatively impacts on the CPG uptake (Dixon-Woods et al., 2013) or results in little change to practice (Bion et al., 2013). CPGs need to be adapted to the local context, and implementation strategies need to be co-designed with end users (clinicians) before they can be implemented to promote better adherence and engagement from clinicians.

While audit and feedback, research evidence dissemination, and role modelling by senior clinicians were perceived as helpful work processes in promoting evidence-based practice in CVAD care, their sporadic and inconsistent occurrence posed challenges. Audit and feedback is in the reinforcement TDF domain, and role modelling is in the social influences domain of the TDF (Cane et al., 2012). These integration strategies have been commonly used in implementation studies to change clinicians' behaviour (Leeman et al., 2017; Lin et al., 2020b). The fact that participants in this study perceived that the regular safety checks at the beginning of their shift was helpful to ensure their adherence to the ICU CVAD policy, is further evidence that integrating tasks into work processes is helpful for optimal adherence. As such, integrating these activities (regular audits and research evidence sharing activities) into senior staff members' routine work processes could ensure the ongoing sustainability of optimal compliance with recommended practices (Leeman et al., 2017).

At the individual level, barriers to adherence encompassed knowledge deficits (in the *knowledge of task environment* domain in TDF (Cane et al., 2012)) and applying knowledge in practice (*procedural knowledge* domain in TDF (Cane et al., 2012)) in this study. Although all participants completed annual aseptic technique training and assessment, and had access to the CVAD policy, there was a lack of clarity on its practical application. Identifying the root cause of suboptimal practice is vital to designing tailored interventions that yield meaningful change (Baker et al., 2015). Revision of the ICU CVAD care policy and bolstering staff education on electronic systems and how to apply practical knowledge (e.g. how to determine the CVAD depth at skin and clean the CVAD access ports) are essential steps.

Another barrier at the clinician level, which sits within the *beliefs* domain in TDF framework (Cane et al., 2012), was the misconception that hats and masks were not necessary when assisting CVAD insertion. Similarly, the perception of not cleaning the CVAD access ports for 15 s and waiting for it to dry only occurred in emergency situations was incorrect because we observed this practice in non-emergency situations (Lin et al., 2022). The reason behind this, could be related to the fast-paced work in the ICU environment. Behaviour change interventions including goal setting, planning, peer behaviour comparison, and audit and feedback that were proven to be effective in improving hand hygiene (Sands et al., 2020) which has similar compliance issues (must clean hands thoroughly for 30 s), may be considered to improve adherence in evidence-based CVAD care.

Patient participation in care has become a key consideration for healthcare organisations in recently years, this sentiment also extends to family members in the ICU when patients are not able to participate (Naef et al., 2021). Patient and family-engagement has been considered both feasible and acceptable in the ICU for a range of different contexts including nutrition (Marshall et al., 2017; Marshall et al., 2016), mobilisation (Sosnowski et al., 2023), delirium screening (Fiest et al., 2020) and shared decision making (Heyland et al., 2018). While there are no reports of how patient and/or family engagement in CLABSI prevention might be undertaken, strategies used in other contexts such as oncology could be adapted to empower patients and families in CVAD care within the ICU setting (Suttle et al., 2019). For example, improving patients' knowledge on clinicians' expected behaviour, and encouraging patients to voice concerns (Suttle et al., 2019) could be used to improve patient/family participation in CVAD care in ICU.

Limitations

This study was conducted in a single setting and the publication of this paper has been delayed. As such, the findings may not be generalisable to other clinical areas or settings. However, the recommendations for improving adherence to evidence-based practice remain applicable. Finally, the rigorous approach we took to have an in-depth understanding of the issues may be used in other quality improvement projects.

Conclusion and recommendations for practice

This study offers insights into the facilitators and barriers of evidence-based practice in CVAD care and CLABSI prevention in the ICU. Facilitators such as using explicit language in clinical policy, having a dedicated staff leading the quality and safety practice, the design of the electronic medical record system which embedded reminders in the system, and a thorough staff orientation program, helped to promote recommended practice in the ICU. Future tailored interventions that address common barriers, such as implicit language use when implementing evidence-based practice in CVAD care, integrating audit and back into senior nurses' work processes, will be important to bring effective change and improvement to clinical practice. Patient/consumer participation in CVAD care is crucial and important to be explored in future research to ensure patient safety.

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.

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