

Original Article

Barriers to implementation of preoperative urostomy site marking in nurse-physician cooperation: A qualitative study based on the Theoretical Domains Framework



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ABSTRACT

Objective: This study aimed to understand the barriers to nurse-physician collaboration in implementing preoperative stoma site marking using qualitative research methods following Theoretical Domain Framework.

Methods: A qualitative descriptive study using semi-structured interviews was conducted from March to June 2023 in the urology departments of nine tertiary hospitals in China. Twelve urologists and eight enterostomal therapists (ETs) were recruited using purposive sampling. Audio recordings were transcribed verbatim and data were analyzed using content analysis.

Results: Five themes were identified in the study: shortage of manpower and stoma care products, lack of standard and regulations, lack of motivation and intention, inconsistency of expectation on consequences, and difficulties in cooperation.

Conclusion: This study indicated that the barriers to implementation of preoperative urostomy localization among urologists and ETs. Institutions, resources, clear career plans, and performance feedback can increase motivation and intention. In addition, the lack of cooperation between urologists and ETs is a key factor for poor urostomy localization implementation, which calls for effective and equal communication between doctors and nurses.

Introduction

Bladder cancer (BC) is one of the most common malignant tumors of the urinary system, and its prevalence is increasing every year.¹ The 2020 Global Cancer Statistics report shows that the global incidence rate of BC is 5.6/100,000 and the mortality rate is 1.9/100,000.^{2,3} Although the age-standardized incidence and mortality rates of BC in Chinese people are

lower than the global level, there were about 92,000 new cases of BC and 43,000 deaths in China in 2022, accounting for 16.1% of the global new cases.⁴

Muscle invasive bladder cancer (MIBC), a fatal disease, accounts for about 30% of BCs currently. Radical cystectomy (RC) combined with urinary diversion (UD) is the standard treatment for MIBC,⁵ and the five-year survival rate for patients undergoing RC + UD is as high as 70%.⁶ However, the experience of BC patients is one of the poorest

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compared to other cancers.⁷ RC and UD for BC results in a change in the patient's original mode of urination, and the patient must permanently wear a stoma bag. The change in their body image reduces optimism and decreases social activities, leading to anxiety and depression.^{7,8} Additionally, the cost of urostomy care, incontinence, pain, and potential complications may increase patient suffering, reduce quality of life, and even shorten survival time due to altered physiology.⁹

A UD needs to be tailored to the patient's specific situation, such as age, self-care, tumor status, comorbidities, life expectancy, patient preferences, and cognitive abilities.⁴ Individualized provision of an optimal stoma site is directly related to patient independence in postoperative self-care, predictable pouch wear times, and resumption of normal activities.¹⁰ Preoperative stoma site marking is an important preoperative intervention that enables the selection of the most appropriate stoma site for an individual, which can enhance the patient's early adaptation and acceptance of the stoma site and improve the patient's confidence in postoperative self-care.¹¹ An appropriate stoma site can effectively prevent postoperative stoma and skin inflammation and is also an important factor in improving patients' quality of life, self-confidence, and social reintegration. It was found that preoperative marking of the stoma site was the only factor affecting the incidence of stoma-related complications, reducing complications by 53% and skin problems by 59%.¹²

Several international guidelines highlight the value and importance of preoperative stoma site marking, which should be a mandatory procedure in clinical settings.^{13,14} The WOCN Society and AUA Position¹⁰ emphasize that urologists and certified ostomy nurses are the optimal clinicians for stoma site marking. In China, both enterostomal therapists (ETs) and Wound, Ostomy and Continence Nurses (WOC Nurses) are certified ostomy nurses with the same responsibilities. The Chinese guideline recommend that stoma site marking should be performed by both WOC nurses and urologists 1 day before surgery.¹⁵ It was found that physician-nurse co-engagement in the preoperative stoma site marking can effectively reduce postoperative stoma complications, improve self-care ability, reduce medical costs, and improve patients' quality of life.¹⁵ However, the implementation rate of stoma site marking in China is not high, and there is often an inconsistency between the marking and the actual stoma position. Several studies have shown that some BC patients undergoing RC had no preoperative stoma site marking, which resulted in a low accuracy rate of the optimal stoma site for BC patients, and caused a lot of trouble for the patients' postoperative self-care. At the same time, multiple barriers such as healthcare professionals, patients, and the overall healthcare environment may obstacle to guidelines practice.^{16,17}

According to the Institute of Medicine, there is often a delay between the discovery of evidence-based interventions and their integration into practice settings. Understanding the barriers to evidence translation can help professionals target the translation of evidence into practice.

The Theoretical Domain Framework (TDF) was proposed in 2005 to explore the factors affecting target behavior change and the methods to implement behavior change.¹⁸ At present, the framework has been used to guide health behavior change, guide treatment adherence, and promote the application of evidence in clinical practice.^{19,20}

Therefore, the purpose of this study was to understand the barriers to urologists-ETs collaboration in implementing preoperative stoma site marking using qualitative research methods following theoretical domain framework.

Methods

Study design

This study used qualitative research methodology. It allows researchers to gather comprehensive information through semi-structured in-depth interviews and to interpret the barriers to implementation of stoma site marking by urologists and ETs.²¹ This study followed the Criteria for Reporting Qualitative Research (COREQ).²²

Setting

Participants were recruited from nine urology departments in tertiary hospitals in Beijing, Harbin, Tianjin, and Qinghai, China. These departments are certified in radical BC surgery with more than 50 operations per year and have ETs.

Participants and recruitment

Purposive sampling was applied to select urologists and ETs. The inclusion criteria included urologists and ETs who had worked in urology for more than five years. Details of the inclusion and exclusion criteria are presented in Table 1. Potential participants were contacted by the corresponding author through the Chinese Medical Association Urology Specialty Committee. After introducing the purpose of the study and confidentiality principle, all urologists and ETs signed a written informed consent before participated in the study. Interviews were conducted in a quiet office after establishing a trusting relationship with the participants.

Data collection

Face-to-face semi-structured interviews were conducted by the researchers between May to June 2023. The interviews were recorded by the researchers using an audio recorder. The interview guideline was created based on the research questions and developed through pre-interviews with 2 participants. The final interview guideline consisted of 12 open-ended questions based on the theoretical domains framework (Supplementary Material). All interviews were transcribed verbatim within 24 hours and the transcripts were returned to the participants for correction.

Before the study, the researchers reported their experiences, interests, and preferences to understand how these factors might influence research conduct. During data collection and analysis, researchers continually reflect on and document biases caused by various individual characteristics in order to optimize the presentation of facts.

Data analysis

Data were collected and analyzed simultaneously. When the data is saturated, we stop collecting data.²³ Data were analyzed using content analysis and managed using Nvivo (11, QSR).²⁴ All members of the research team work in the field of urology and the authors have experience in qualitative research. The researchers read the primary data several times, then broke them down into smaller and more manageable meaningful units, followed by coding, creating categories, and grouping them into higher-order themes.²⁵ The researchers provided support and refined the themes. All researchers discussed problems encountered during data analysis weekly to reduce bias. Differences were then identified and discussed until agreement was reached within the team. All transcripts were described, transcribed and analyzed in Chinese, and then translated into English.

Table 1
Inclusion criteria and exclusion criteria of the participants.

Eligibility criteria	Urologists	Certified ostomy nurses
Inclusion criteria	1. Doctors who have at least five years of experience for radical cystectomy 2. Attending physician or above	1. Nurses qualified as enterostomy therapists or WOC nurses 2. At least five years of ostomy care experience in an urological department
Exclusion criteria	Not able to speak Mandarin	Not able to speak Mandarin

WOC, Wound, Ostomy and Continence.

Ethical considerations

This study was approved by the Ethics Committee of Peking University Health Science Center (IRB No. IRB00006761). All participants were informed of the purpose, content confidentiality, and voluntariness of the study and provided written informed consent. The participants were informed that it was possible to withdraw consent to participate. Informed consent was obtained from all participants. All methods were conducted in accordance with the relevant guidelines and regulations.

Results

A total of 12 urologists and 8 ETs were interviewed for an average duration of 35 minutes (ranged 27–46 minutes). The average age of the urologists was 44.3 years (ranged 33–53 years), of which 9 were associate chief physicians or above. Of the 12 urologists participants, more than half (58.3%) had Doctor's degree. The average age of the ETs was 37.4 years (ranged 33–40 years) and 6 of them were supervisor nurse and above. Of the 8 ETs, all had a Bachelor's degree or above. Table 2 shows the detailed demographic characteristics of the participants. The relationship between findings and research questions is shown in Fig. 1.

Theme 1: Environmental context and resources: shortage of manpower and stoma care products

Shortage of ETs and urologists

Most participants indicated that there were few ETs in their departments and that ETs and urologists were overworked, resulting in a lack of time for implementation.

“The ETs work in our department has been overloaded, and we even have to use the rest time to mark urostomy site.” (ET6)

“Training more ETs to share the heavy work and ensure that everyone's workload is within their reach is the key to improving the urostomy site marking rate.” (U6)

“A detailed understanding of the patients' medical history, lifestyle, and physical examination is needed to choose an optimum urostomy site. Due to my heavy workload, some of us have no energy to implement.” (U2)

Lack of ostomy bag for adaptation

The guidelines recommend wearing the ostomy bag before the operation. Preoperative wearing experience was limited due to a lack of stoma bags.

“Adequate ostomy bags can provide patients with product experience and help them adapt to postoperative life in advance.” (ET6)

Theme 2: Behavioural regulation: lack of standard and regulations

Lack of standardized management

Most participants reported that the department lacked the standardization, procedure, and process of preoperative urostomy site marking.

“There is a lack of a uniform standardized process to make preoperative positioning more rational and standardized.” (ET4)

“There must be regulations for standard preoperative stoma positioning.” (U10)

“Existing preoperative stoma regulations have not yet refined the positioning methods and steps.” (U5)

Lack of protocols for preoperative positioning in an emergency state

Stoma positioning was commonly missing in patients undergoing unplanned surgery due to the lack of protocols for preoperative positioning in a state of emergency.

“For example, in emergency surgery, the surgeon does not have time to locate the stoma, which we usually do during surgery.” (U10)

Lack of performance appraisal system

Participants reported that the departments did not have a performance evaluation system for preoperative stoma marking. There are no rewards or punishments for whether or not the marking is implemented. Thus, participants lacked the motivation to implement it.

“Preoperative ostomy positioning should be included in the performance appraisal system to encourage clinicians to perform according to the standards.” (U11)

Table 2
Demographic characteristics of the participants.

Participants	Gender	Age (years)	Education	Years of surgery	Characteristic	Title
U1	Male	42	Master's degree	10	Urologist	Associate chief physician
U2	Male	33	Doctor's degree	3	Urologist	Attending physician
U3	Male	39	Doctor's degree	7	Urologist	Associate chief physician
U4	Male	48	Doctor's degree	10	Urologist	Chief physician
U5	Male	39	Doctor's degree	3	Urologist	Associate chief physician
U6	Male	45	Doctor's degree	15	Urologist	Chief physician
U7	Male	38	Doctor's degree	3	Urologist	Associate chief physician
U8	Male	50	Doctor's degree	12	Urologist	Chief physician
U9	Male	51	Master's degree	20	Urologist	Associate chief physician
U10	Male	48	Master's degree	20	Urologist	Chief physician
U11	Male	45	Master's degree	10	Urologist	Attending physician
U12	Male	53	Bachelor's degree	14	Urologist	Attending physician
Participants	Gender	Age (years)	Education	Years of ET	Characteristic	Title
ET1	Female	43	Bachelor's degree	10	ET	Supervisor nurse
ET2	Female	39	Bachelor's degree	21	ET	Supervisor nurse
ET3	Male	33	Bachelor's degree	11	ET	Supervisor nurse
ET4	Female	36	Bachelor's degree	17	ET	Nurse practitioner
ET5	Female	40	Bachelor's degree	16	ET	Associate chief nurse
ET6	Female	35	Master's degree	18	ET	Nurse practitioner
ET7	Female	34	Bachelor's degree	12	ET	Supervisor nurse
ET8	Female	39	Bachelor's degree	20	ET	Supervisor nurse

ET, enterostomal therapist.

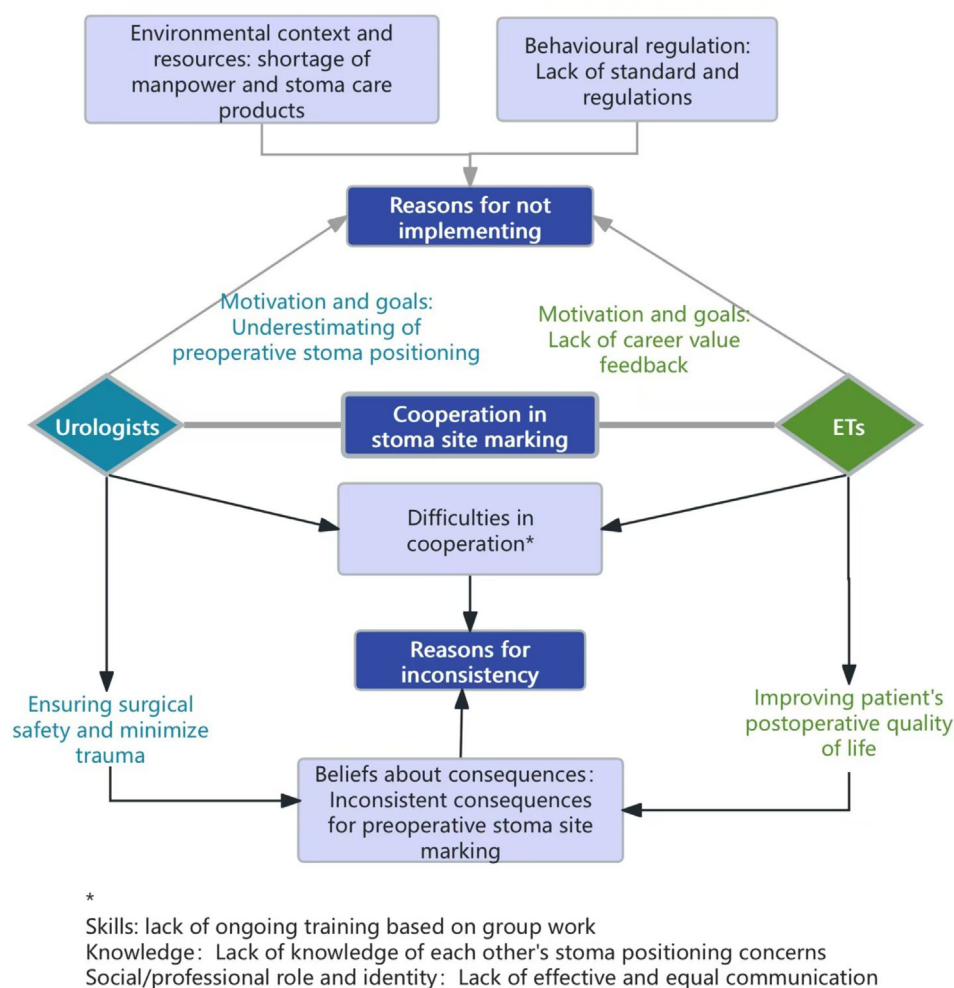


Fig. 1. Barriers of preoperative urostomy site marking.

"Implementation of preoperative stoma marking should be mandatory and directly impact performance evaluations." (U5)

Lack of evaluation criteria for preoperative ostomy localization

Participants reported that the indicators used to evaluate the effectiveness of the implementation of ostomy positioning were unclear, such as criteria for ostomy consistency and patient health outcomes.

"The patients' intraoperative stoma position is more or less deviated from the preoperative positioning. However, there is no definition of deviation in the current guidelines or other expert consensus." (ET1)

"For the sake of science, I think it is necessary to develop a patient satisfaction or complication scale for ostomy localization." (U8)

Theme 3: Motivation and goals: lack of motivation and intention

Underestimating of preoperative stoma positioning

Some urologists underestimate the importance of preoperative stoma positioning or the importance of the physician in stoma positioning. As a result, they do not perform preoperative stoma marking.

"I believe that urologists who do not participate in preoperative ostomy setting may do so because they believe that it is ineffective." (U11)

"Urologists should undoubtedly collaborate with ETs to locate, but ETs can also locate on their own." (U12)

Lack of career value feedback for ETs

The majority of ETs reported feeling unmotivated for a variety of reasons. Firstly, the salary of ETs, like that of specialist nurses, does not accurately reflect their workload and value. Secondly, career prospects for ETs were limited because some hospitals did not yet offer outpatient urostomy care. The value of ETs' work is limited to urology wards. Thirdly, preoperative stoma marking by ETs was not acknowledged, as evidenced by the urologist's disregard or distrust of the preoperative site markers of ETs.

"ETs and general urological nurses are paid the same salary, and the ET's work performance are not included in wages. Many ETs rely on enthusiasm to continue their work, but that is not a long-term solution." (ET2)

"Some hospitals have urostomy care clinics, which can reflect the value of ETs, but my hospital does not have a care clinic. Internet-based patient follow-up is documented and performance-based, which immediately demonstrates the value of care, but it is not yet available in our hospital." (ET3)

"Some urologists may not have trust in the marking by the ETs. I would have the feeling of not being taken seriously by the urologists." (ET5)

Theme 4: Beliefs about consequences: inconsistency of expectation on consequences

Urologists and ETs had different concerns about stoma site and approaches to solution. The ETs tended to choose a position that would

facilitate postoperative stoma care and improve quality of life, whereas the urologists often chose the stoma location to ensure the safety and reduce the trauma during the surgery.

Ensuring surgical safety and minimize trauma

"The reason why the stoma site did not match with the preoperative choice is mainly due to the specific physiological structure of the patient, such as the length of the mesentery, the adhesion of the intestines, the length of the ureter, and in some patients, there is tumor invasion of the ureter, so the actual situation in surgery is also related to the site." (U2)

"Reselecting of a stoma near the laparoscopic incision may complicate both wound healing and stoma maintenance." (U3)

"Urologists may choose to utilize a laparoscopic incision as an ostomy site to reduce trauma, but this can be problematic for postoperative care." (U7)

Improving patient's postoperative quality of life

"From ET's perspective, more aspects of the patient's postoperative life and postoperative care are taken into account." (U3)

"Long-term or short-term difficulties can be avoided with proper stoma positioning; if the location is suboptimal, dermatitis becomes more common, and with it comes increased psychological distress for both patients and caregivers." (ET8)

Theme 5: Difficulties in cooperation

Studies have found that there are several difficulties in cooperation between urologists and ETs, because they do not understand each other's knowledge and skills, and they find it difficult to communicate equally.

Skills: lack of ongoing training based on group work

Participants observed a lack of ongoing education and training for urologists on stoma positioning. As a result, urologists lack an understanding of ET positioning details and are unable to collaborate properly to maintain consistent ostomy positioning.

"Increased stoma positioning training is essential and ongoing training of clinical staff is required." (U11)

"I have an understanding of the principles of stoma positioning, but there is still a lot I do not know about the specifics of the practice." (U11)

"I have learned some about the principle of ostomy positioning in recent years, but there are still many specific practices I do not know." (U1)

Knowledge: lack of knowledge of each other's stoma positioning concerns

Urologists and ETs had incomplete knowledge and different understanding of urostomy localization depending on the respective subjects. Urologists were not aware of the latest knowledge on stoma site. ETs were unaware of the surgical procedures and surgical protocols, resulting in incomplete consideration of preoperative positioning.

"I'm not too sure about the method of standard positioning, we go to the stoma in this position next to the rectus abdominis muscle, but maybe the criteria for positioning the stoma are more precise and detailed now." (U5)

"The ETs do not take into account the exceeding expectations encountered by the urologist during the operation, which may also change the preoperative stoma site." (ET5)

"The ETs may not have a good understanding of the operation procedure and the patient's disease, which leads to inconsistent preoperative and postoperative positioning." (U11)

Social/professional role and identity: lack of effective and equal communication

Urologists are considered the leaders of the urostomy team and have the authority to determine the location of the stoma. Sometimes it is difficult for ETs to express their thoughts and opinions, and the stoma site they have identified may be overlooked by the urologist.

"Some urologists may not trust the stoma positioned by the ETs." (ET5)

"ETs should follow the stoma location marked by the urologist." (U3)

"The lack of collaboration and communication between the urologists and the ETs leads to a lack of understanding of each other's work." (U4)

"Urologists and ETs are so busy with their work that they rarely have the opportunity to discuss the choice of stoma location together." (ET3)

"The urologist and ETs should communicate at least once before surgery, but there is no set time for discussion." (U4)

Discussion

This study reveals the barriers to translating the evidence through a theoretical domain framework. The study found that lack of motivation and intention to implement for urologists and ETs as well as lack of behavioral regulations and material resources led to a lack of implementation of preoperative stoma marking. A lack of effective cooperation and different beliefs about the consequences led to inconsistencies between the preoperative and actual stoma positions. This study interviewed key stakeholders - urologists and ETs - to ensure that both perspectives on the gap between evidence and clinical practice in preoperative urostomy site marking were considered. To obtain more information, the researchers strictly followed the qualitative descriptive research methodology and reflected after the interviews to minimize bias from personal characteristics during data collection and analysis. The participants in this study were urologists and ETs from tertiary hospitals in several cities in China, allowing a more comprehensive description of the current status and barriers to preoperative urostomy site marking in China.

The study found that physicians underestimated the importance of preoperative stoma positioning and ignored the importance of the physicians' role in stoma site marking. Currently, most physicians still followed traditional methods of stoma site marking, which is consistent with Chen's study about factors of low optimal stoma site selection by physicians.²⁶ According to the iceberg model, motivation is the bottom layer and is difficult to change once it is formed.²⁷ Therefore, the most effective way to improve the implementation of preoperative stoma positioning is to improve professionals' motivation.²⁷ However, there is a lack of interventions to motivate preoperative stoma positioning. A large number of studies have applied the iceberg theoretical model to construct interventions to improve the competence of urologists and ETs, which is worthwhile for managers to learn from.^{28,29}

The reason for the lack of motivation for stoma site marking among ETs, in contrast to urologists, is the lack of career planning and performance feedback, which is consistent with Zhang' study.³⁰ In all theses studies, increasing the professional value of ETs was mentioned as the main motivation for implementing preoperative stoma site marking. First, it is necessary to clarify the scope of work of ETs. In recent years, the Chinese nursing workforce has developed rapidly, but the work responsibilities and scope of ETs are not clear, and they lack the independence to implement specialized nursing services, resulting in a lack of recognition of nurses' professional identity and status.³¹ Second, improving salaries of ETs is the most immediate career feedback. A study reported that the salary of WOC nurses in the United States is about 50% higher than that of general nurses.³² However, in China, the advantages of specialized nurses are mainly reflected in their titles, promotions and training opportunities, but the salary is the same as that of a regular

nurse. The salary of ETs do not reflect their specialized value, which to some extent affects the work motivation of specialized nurses. The key to solving the above problems is for hospitals to establish an incentive system for ETs according to the actual situation, and to reflect the difference between them and general nurses.³³

Insufficient ETs and even fewer full-time ostomy personnel was also a reason for the low implementation rate of preoperative ostomy site marking. A study found that 81.5% of 885 WOC specialty nurses did not provide full-time ostomy care.³⁴ Compared with other developed countries, training of WOC nurses started relatively late in China, and the first international professional training school for wound, ostomy and continence nursing was established in China only in 2010. There are now only 1638 ETs in China.³⁴ It is therefore imperative to train more full-time ETs. Firstly, it is important to relax the inclusion standards for ETs. The WOCN Association categorizes ostomy nurses into four different levels based on the education and experience, requiring a bachelor's degree and above.³⁵ However, there are some ETs in China whose work experience and clinical practice skills are at a higher level. Therefore, it is recommended to relax the academic requirements for those with longer working years and rich clinical experience to solve the shortage of ETs. The training of ETs with a master's degree requires a long-term program to gradually improve the functional performance of ETs in their roles as managers, researchers, and innovators.³⁶ Second, the joint approach accelerates the training of ETs. In order to cope with the shortage of ETs, many urology departments have an ET who leads a group of trained nurses to implement WOC care. With the increase in the number of ETs in China, more and more ETs are able to become teachers to train nurses in this unit.³⁷ The theoretical learning time of ETs training in China is longer than in the United States, but the clinical practice time is only half of that in the United States, which is not conducive to the accumulation of practical experience for ETs.³⁷ Thus, training materials can be developed according to the national situation and the current status of ET, and theoretical learning and practice time should be adjusted. Third, the responsibilities of ETs need to be clearly defined. Wound ostomy incontinence nurses in the United States may work full-time in wound care and ostomy care.³⁸ Hospitals have clear work hours and job content requirements for ETs, so clarifying ETs positions and responsibilities is a necessary way to develop full-time ETs.³⁹

Additionally, the lack of a behavior regulation on preoperative stoma site marking (for both emergency operation and planned operation) in hospitals has prevented the preoperative stoma positioning for not yet being included as a mandatory procedure to stoma surgery. In general, changes in care procedures need to be implemented by the issuance of a guidance document by the regulatory authority. Some countries have even made the application of evidence mandatory by incorporating it into legal provisions so that it is legally guaranteed.⁴⁰ Each state in the USA has a WOC regulation and occupational standards.³⁷ Therefore, in order to strengthen the implementation of preoperative stoma marking, hospitals should adopt the guidelines and develop a regulation about preoperative stoma positioning management that meets the actual situation of the hospital. It is better to include preoperative stoma positioning in the performance appraisal to improve the motivation of healthcare workers, while enforcing the behavior of preoperative stoma marking among employees. In addition, the provision of adequate stoma products should be included in policy. Psychological studies have shown that the preoperative period is the most important time for patients to accept the ostomy and reduce stigma, so healthcare professionals should support patients in facing the upcoming surgery and stoma care in pre-surgical period.⁴¹ Adequate stoma products are conducive to the preoperative patients' experience of the stoma bag and postoperative life, which reduces the patients' fear of wearing stoma bag and enhances the patients' cooperation in preoperative stoma positioning, and helps standardize the behavior of medical staff in implementing preoperative stoma marking.⁴²

Moreover, urologists and ETs have different perspectives on optimal stoma site, and inadequate communication and lack of trust between them make it difficult to reach consensus on stoma position. This may be

due to differences in knowledge, skills and backgrounds between individuals, leading to frustration and conflict between different roles, as well as isolation and hostility between health professionals.⁴³ This is not conducive to ensuring the patients' intraoperative safety and quality of life after surgery.^{44,45} To improve the overall patient experience, the World Health Organization (WHO) calls for higher education and health care organizations to provide opportunities for students and health care professionals to learn and work together in an international way. Inter-professional education & collaborative practice improves the sense of teamwork and relationships, which includes mutual respect, trust and shared decision-making. It is vital to create a stable working environment and opportunities for team members to interact and develop a team mindset.⁴⁶

Limitations

This study investigated the barriers to the implementation of urostoma marking by doctors and nurses respectively, which did not take the perspectives of patients and their families into account. In addition, this study lacks the scene of unplanned or emergency stoma surgery, making this study more applicable to preoperative stoma location in the ward.

Conclusions

This study revealed barriers of preoperative urostomy localization in the implementation of a joint effort by physicians and nurses. Institutions, resources, clear career plans, and performance feedback can increase motivation and intention. In addition, this study also found that the lack of cooperation between doctors and nurses is a key factor in the implementation of stoma site marking, which calls for effective and equal communication between doctors and nurses.

CRediT authorship contribution statement

Xiaotian Zhang: Conceptualization, Methodology, Software, Visualization, Writing—original draft, Writing—review and editing, Investigation, Formal analysis; Funding acquisition; Jianfei Ye: Methodology, Writing—review and editing, Investigation, Formal analysis, Funding acquisition; Xiaolong Li: Investigation, Writing—original draft, Formal analysis; Xueqian Ma: Investigation, Writing—original draft, Formal analysis; Dong Pang: Formal analysis, Writing—review and editing; Haihong Zhang: Investigation, Formal analysis; Rui Shi: Investigation, Formal analysis; Jing Liu: Investigation, Formal analysis; Lei Zhang: Investigation, Formal analysis; Jia Wang: Investigation, Formal analysis; Xiaojun Jia: Investigation, Formal analysis; Jianying Chen: Investigation, Formal analysis; Haifang Zhang: Investigation, Formal analysis; Liyan Cui: Investigation, Formal analysis; Chunxia Liu: Conceptualization, Supervision, Resources, Data curation, Project administration. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Ethics statement

This study was approved by the Ethics Committee of Peking University Health Science Center (IRB No. IRB00006761) and was conducted in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All participants provided written informed consent.

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Declaration of competing interest

The authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author, Chunxia Liu, upon reasonable request.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

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Appendix A. Supplementary data

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