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Procedural skill maintenance: What it means to physicians, how it motivates them, and what stops them from doing so

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Abstract

Introduction: Maintenance of procedural skills is crucial for paediatric emergency medicine (PEM) physicians to provide high-quality care. A study by Lin-Martore et al. (2021) in the US identified key themes in conceptualising procedural skill maintenance (PSM), its motivations, and barriers to maintenance. However, the difference in culture brings into question the validity of their findings in other contexts. To determine its applicability specifically in an Asian context, this study aims to replicate the study at KK's Women and Children Hospital (KKH), focusing on PEM physicians. While the findings are limited to a single hospital, they provide valuable insights into challenges encountered by PEM physicians.

Methods: A general qualitative approach was used through semi-structured interviews. Participants were recruited through email. Interviews were conducted via Zoom and subsequently de-identified and transcribed. The data was coded manually through thematic analysis, identifying key themes.

Results: Fifteen PEM physicians were interviewed. Participants conceptualised PSM through technical aspects and measured competence through objective and subjective measures. General motivation themes found the (1) desire to provide optimal patient care, (2) procedural competence as part of the identity of a PEM physician who teaches and performs procedures, and (3) desire for choice when alternatives are present. Barriers included limited time, support, and opportunities.

Conclusion: The study found that the themes from the original study are applicable in KKH, featuring SDT concepts prominently. Practical recommendations for KKH were proposed. Future research can focus on the challenges and gaps in maintaining procedural skills and develop strategies to improve PSM in PEM physicians.

Keywords: *Procedural Skill Maintenance, Singapore, Emergency Medicine, Qualitative, Paediatric Medicine*

Practice Highlights

- Comparisons with the original study in the US were made.
- Understanding of procedural skill maintenance (PSM) was assessed.
- Motivators of PSM are identified.
- Barriers to skill maintenance are constant across studies.
- Current healthcare standards are maintained but medical advancements are limited.

1. INTRODUCTION

Procedural skills are critical in the training and competency of healthcare professionals. Paediatric Emergency Medicine (PEM) physicians may need to perform a wide range of procedures, including intubation, cannulation, and other life-saving interventions and are often the primary care physician

first contacting the patient. As such, maintaining the procedural skills of PEM physicians is critical to ensure patient safety and high-quality care. However, many critical procedures are not common and the wide variety of procedures that fall under their purview makes maintenance of such skills challenging (Cabalatungan et al., 2020). Hence, there is a need to investigate the

current state of procedural skill maintenance (PSM) in physicians to evaluate current systems and implement new policies if necessary.

According to a study by Lin-Martore et al. (2021), three themes revolving around motivation for PSM have been identified based on self-determination theory components of autonomy, competence, and relatedness (Ryan & Deci, 2000): (1) desire for optimal patient care and fear of suboptimal performance, (2) procedural competence is part of a PEM physician's identity who teach and perform procedures and (3) desire for accessibility and choice in PSM.

As the research was conducted in the US, it is important to determine if such findings are generalisable to and replicable within an Asian society that may have different values than Western, Educated, Industrialised, Rich, and Democratic (WEIRD) societies (Henrich et al., 2010; Jones, 2010; National Academies of Sciences et al., 2019).

This paper aims to replicate the research design by Lin-Martore et al. (2021). It examines the unique challenges of maintaining proficiency in a high-stress environment within the paediatric emergency department (PED) of KK's Women and Children's Hospital (KKH) in Singapore.

This study examines the following research questions: (1) To what extent do the three themes characterising motivation for PSM identified from the Lin-Martore study in the US apply to Singapore? (2) To what extent do the barriers to motivation and skill maintenance identified from the Lin-Martore study in the US apply to Singapore?

Additionally, this study aims to identify any gaps or challenges in the current skill maintenance process and make recommendations for improving the maintenance of procedural skills in PED physicians.

II. METHODS

To tackle this hypothesis, the study design involved conducting qualitative interviews with participants to elicit key themes through thematic analysis. The themes would then be compared to the original study to determine its validity and subsequently formulate applications for use in Singapore.

Participants were recruited using the Purposeful Sampling Method through an email invitation. The selection criteria required participants to be faculty currently working in the Emergency Department of KKH with varying years of experience. They must specialise in PEM and have been working in the Emergency Department of KKH for at least 2 years. Participants consented to participation and recordings. The research team consisted of an undergraduate student (IT) and a PEM senior consultant (SG) with 12 years of experience in PEM.

A. Interview Questions

Based on the original study, most of the interview questions were kept the same and revolved around the conceptualisation of PSM using SDT concepts of autonomy, relatedness, and competence together with its motivations and barriers (Bradbury-Jones et al., 2017; Kahlke, 2014). However, the original question regarding autonomy was replaced to determine the receptiveness of participants toward novel techniques when existing protocols are already enacted by one investigator (SG).

B. Interviews

One investigator (IT) conducted interviews and was involved in the development and refinement of the interview guide and review of the transcribed interviews. This addressed the potential for reduced participant candour due to established relationships and mitigated the potential for less explicit responses due to familiarity with certain jargon. Similar to the original study, 30 – 45-minute semi-structured interviews were conducted and recorded via video-conferencing software (Zoom Cloud Meetings) using a general qualitative approach from July 2022 to February 2023. Following this, they were de-identified and transcribed. No participant was interviewed more than once. Interviews were conducted until data saturation was achieved.

C. Thematic Analysis

The data underwent structural coding for categorisation based on research questions and topics by one investigator (IT). In line with thematic analysis, ideas from the initial study were used as a framework for identifying key ideas relating to concepts from SDT by both investigators (IT and SG). Additional ideas elicited from interviews were then integrated into the codebook. Key concepts and patterns were then identified by both investigators.

The data was manually coded using Microsoft Office. Having perspectives from a PEM physician and nonphysician in the research team provided greater theoretical analysis and practical applications of SDT in the context of KKH.

III. RESULTS

A. Participant Demographics

Fifteen PEM physicians with 6-32 years of experience were interviewed (Table 1). Participants worked shifts with and without learners, including medical students.

Sex	
Female	73.3% (11)
Male	26.7% (4)
Race	
Ceylonese	6.7% (1)
Burmese	6.7% (1)
Indian	20.0% (3)
Filipino	33.3% (5)
Chinese	33.3% (5)
Age	36 - 56
Years of Practice	6 - 32
Average shifts worked/month (self-reported) *	8 - 24
Appointment	
Senior Staff Registrar / Associate Consultant	46.7% (7)
Senior Consultant / Consultant	13.3% (2)
Senior Resident Physician / Resident Physician	40.0% (6)

Table 1. Participant demographics (n=15)

Note: Shifts are 8 hours long.

B. Thematic Analysis

The themes were organised based on the research results and findings of the original study (Table 2).

Topic	Theme	Exemplar Quote
Conceptualisation of PSM	PSM is understood through technical aspects	“Procedure skill maintenance is highly dependent on how many procedures you do on your shifts regularly, so automatically you are always in touch with it. So other than that, a touch-up or catch-up class or a refresher class or training is also one of the ways of doing it.” (interview 9).
	Measuring competence through objective and subjective measures	“So, for competence, number one you need to have the confidence of doing ... you can anticipate the complications or the other side effects during the procedures and that you must be able to deal with these possible complications ... So that if you are mentally prepared for that and if you can do the necessary skill, then it means that you know that you are ready for that.” (interview 7)
General Motivation	Desire to provide optimal patient care (competence)	“I need to maintain these skills to practice and be professional. It is important and lifesaving. It is for the sake of the patient that we need to keep practicing this.” (interview 14)
	Procedural competence as part of the identity of a PEM physician who teaches and performs procedures (competence and relatedness)	“You need to do it. If it's a procedure that is important in the practice of emergency medicine. Procedures that we'll be expected to know like intubation, M&R, chest tube insertion, suturing ... Point-of-care

		ultrasound skills. So, all these are important to know and to maintain.” (interview 2).
	Desire for choice when alternatives are present (autonomy)	“So long as it’s a thing that will help in patient treatment, it would be good to learn, especially the new things that we haven’t been doing last time... If the regional block is somehow more risky and not really needed, then we can still learn it but we may need to choose the one that is most suitable for the patient.” (interview 3).
Barriers to PSM	Lack of opportunities, time, and support	“Time and manpower. I wanted to attend the course but if there were not enough manpower, I would rather not attend if it would compromise the manpower in A&E.” (interview 5) “Some senior doctors will really teach you manipulation and reduction and suturing. But because it’s very fast-paced in emergency and [with] the bulk of the patients coming in, it’s a two-way thing. You must really drive yourself to get the cases and learn and ask for guidance from the senior doctors.” (interview 6)

Table 2. Major themes in procedural skill maintenance

C. Conceptualisation of Procedural Skill Maintenance (PSM)

1) PSM is understood through technical aspects: Participants intuitively understood PSM and operationalised it through technical aspects such as practicing the procedure, attending courses and refreshers, keeping up to date with literature, revisiting the content, and teaching others.

“There should be constant upgrading of yourself either by doing the procedure itself or also upgrading by constantly reading literature and updated books and materials to check new things.”

(interview 3)

“For my TNS, although I try to teach some of the new MOs that come, I have to read back or watch from previous videos to maintain my skills.”

(interview 5)

The ability to teach is based on the protégé effect where through teaching others, knowledge retention increases (Baugh & Scandura, 1999; Chase et al., 2009; Gates, 2019, p. 20). It also allows senior physicians to gauge their competence relative to others. This self-evaluation means that PSM is an abstract concept understood by physicians through a form of social comparison with others.

2) Measuring competence through objective and subjective measures: Physicians listed objective measures implemented for junior doctors such as having third-party physicians evaluate and provide immediate feedback on skills.

“All of us must go through a skill test in the sense that you have to do supervised procedures – X number in the first six months of joining. So, there is a senior who

makes sure that you know what you’re doing and [according to] the correct method, process including you know consent taking and post-procedure care, etc. And once we are supervised, we are ticked off as competent by the senior staff.”

(interview 9)

Confidence and the ability to foresee problems and deal with them are subjective measures that highlight the difficulties in measuring competencies. Many physicians feel confident in their ability to perform a procedural skill if they can do it without hesitation and without committing mistakes.

“If you are quite confident, it is just as easy as using a spoon and fork. You don’t have to think much about it, and you do it at ease with all confidence. It’s like muscle memory plus decision-making.”

(interview 6)

“I think we always know what our backup plan is. So, if it’s incubation then I know if I need to, I can code, call for airway code. There’s another senior on shift who might be able to help. I can call the anaesthetist without even coding if I need to ... I anticipate what’s the problem that’s going to happen.”

(interview 12)

D. General Motivation

On motivation, three themes were identified with the SDT components of autonomy, competence, and relatedness serving as tenets.

1) *Desire to provide optimal patient care (competence):*
“The satisfaction that you have done a good job and that has resulted in a good outcome, gives you the motivation, satisfaction to update, maintain, upskill your skills.”
(interview 1)

Providing optimal patient care is a key motivation. The idea of competence is highlighted through the need to feel capable and effective in providing patient care.

“As a doctor, you are responsible and accountable for your patients, right? You must treat your patient at your best, right? If you're not maintaining your procedural skills, you cannot serve your patient to the best of your knowledge and skill.”
(interview 7)

The concept of duty was highlighted. Physicians felt responsible for providing optimal patient care as part of their values and the right thing to do.

2) *Procedural competence as part of the identity of a PEM physician who teaches and performs procedures (competence and relatedness):* Participants listed several key procedures as part of their repertoire. Essentially, these skills were part of their identity as a PEM physician, making the skills important to maintain.

“The fact that you are the consultant and you need to know everything ... you might be the only one who is the most senior to be able to do it. If nobody can get it done, then it comes down to you.”
(interview 11)

Being the sole physician available to perform a procedure confers responsibility. Hence, skill maintenance is paramount to clinical practice with responsibility acting as a motivator.

“Although we have a lot of experienced doctors who can do it, but for me as a senior, I think I have to learn so that I can supervise in the future.”
(interview 13)

Senior physicians often teach and supervise junior doctors, driving senior physicians to maintain their skills. As senior physicians, individuals may feel a sense of connection and responsibility to other physicians who look up to them as role models.

3) *Desire for choice when alternatives are present (autonomy):* Physicians highlighted a need to ascertain the suitability of certain procedures to the patient. This indicates a desire for choice and autonomy, for the physician to make their judgement on the situation.

“If there is a good alternative that's already in place, unless there's a departmental guideline to force us to change, then I don't see the need to change that. It's sort of stipulated by what they [the department] wants.”
(interview 11)

Regarding novel techniques, physicians tend to fall back on existing, proven techniques. Without adequate reason, physicians are less likely to experiment with new skills unless there is a need to such as inadequacy of existing skills or department policy.

E. Barriers to Maintenance of Procedural Skills

On barriers, the lack of opportunities, time, and support served as the greatest obstacles.

1) *Lack of opportunities:* This encompasses external constraints such as patient flow, allowing junior doctors to perform procedures, and limited course slots

“We need to prioritise who to see for us because if, for example, I just keep doing trauma, it takes me 30 minutes to one hour. Rather than seeing medical cases in which in one hour I can see three to four patients. So, I think it's more of how busy the children's emergency is.”
(interview 10)

Patient flow and load are factors physicians consider as constantly prioritising learning creates delays in patient care, especially seen in high patient volumes. Prioritising efficiency, physicians fall back on well-versed competent skills that are already well-maintained.

“At this stage, we are not doing the procedure ourselves yeah so it's mainly the junior so that would be the barrier for the senior doctors.”
(interview 8)

After senior physicians reach a certain level, there is a transition in roles from a participatory to a supervisory one. With less direct participation in procedures, there are reduced opportunities to practice.

“There are limited slots every 4 years for APLS so the interval of the course is every four years to maintain their accreditation... there is a wait time for it.”

(interview 2)

Accreditation is an objective measure to determine competency in a particular skill. However, limited slots and infrequent sessions create long wait times, leading to some disparity in skill across the faculty.

2) Lack of time

“Time is the biggest factor for anybody. If things like practicing or attending courses are outside of the shift, it would be difficult because you have other things to do and the shifts usually are quite busy.”

(interview 1)

Time limits a physician’s ability to practice skills. Within typical working hours, they need to balance clinical hours with practicing skills not commonly used. Higher clinical hours would mean less time available for workshops or courses for skill maintenance.

3) Lack of support

“I think our limitation is more because we are unable to spare the manpower for dedicated time for updates or refresher courses for the seniors or the permanent staff... Ideally, we would do it more frequently but we have to balance it with the clinical needs.”

(interview 4)

Reduced manpower equates to reduced capacity to send physicians for workshops and courses at regular intervals without compromising on clinical care. As the number of patients remains high, the reduced manpower means that the department cannot afford to send them for courses as there would be insufficient physicians available, constituting a lack of support for PSM.

IV. DISCUSSION

A. Comparison to the Original Study

The purpose of this study is to replicate the findings of Lin-Martore (2021) to determine applicability in an Asian context. A summary comparing the themes in the current study and the original study has been created (Table 3).

Topic	Current Study Themes	Original Study Themes
Conceptualisation of PSM	PSM is understood through technical aspects	PSM lacks a clear definition
	Measuring competence through objective and subjective measures	Ambivalence regarding requirements and the importance of adapting any requirements to practise needs
Motivation	Desire to provide optimal patient care (competence)	Desire to provide optimal patient care and fear of unsuccessful performance (competence)
	Procedural competence as part of the identity of a PEM physician who teaches and performs procedures (competence and relatedness)	Procedural competence as part of the identity of a PEM physician who teaches and performs procedures (competence and relatedness)
	Desire for choice when alternatives are present (autonomy)	Desire for accessibility and choice in maintaining procedural skills (autonomy)
Barriers to PSM	Lack of opportunities, time, and support	Lack of opportunities, time, and support

Table 3. Comparison of major themes

Singapore and the US have different social settings, values, and tenets which may help explain some of the results presented in this study. Singaporean physicians use social comparison within the department for performance evaluation and decision-making. US physicians take a more individualistic approach to self-evaluation with physicians sourcing for courses and defining their own standards (Lin-Martore et al., 2021).

Regarding the conceptualisation of PSM, the current study did not find that participants had difficulty defining PSM, contrasting with the original study where

conceptualisations were intuitive but difficult to verbalise and define. The same tautology exists where being competent was defined as completing the skill, however, the need to know if one is competent before performing the skill is not as prominent in the current study. This is due to the availability of senior staff and specialties available to assist, creating a space that allows independent learning with minimal patient risk. Additionally, the ambivalence regarding requirements is not as present in the current study. Although junior doctors have requirements, autonomy among senior physicians is important and highly respected (Chen & Chung, 2002; Fischer, 2008).

Interestingly, many mentioned confidence as a primary factor determining competence. This contrasts with the original study where participants noted that confidence alone failed to demonstrate competency adequately. In an Asian society where collectivistic efforts are highly valued, being sufficiently confident in performance could be a more accurate representation of competence compared to Western societies.

Regarding motivation, the desire to provide optimal patient care is consistent between studies (Deber, 1994, p. 19; Eisenberg, 1985; Nease & Brooks, 1995). The current study did not find the fear of unsuccessful performance as prominent as that in the original study. A possible reason could lie in the culture of reliance on other specialties. Within KKH, there is a culture of learning, and rather than a complete handover of the patient to other specialties, PEM physicians tend to assist with complex procedures, promoting interdisciplinary learning across faculties. As such, rather than a fear of unsuccessful performance, this is perceived as an opportunity to learn new skills.

Procedural competence is a vital part of a PEM physician's identity across studies. The additional responsibility of being a senior is a key theme in this study. Should seniors fail to upkeep their skills, there is a sense of shame especially when juniors seek aid. Additionally, the failure to upkeep skills also impedes patient care, violating their sense of competence. This holds the greater the seniority.

The desire for autonomy differs in scope across studies. In the original study, skill prioritisation depends on the availability of individuals who possess that skill. Should there be someone with greater experience in that one skill, participants would choose to practice other skills. In the current study, skill prioritisation is dependent on the reliability of the skill and the presence of alternative skills. Should there be an existing skill that is highly reliable, physicians are likely to prioritise it.

Regarding barriers to PSM, a lack of time, opportunities and support are consistent throughout the studies.

B. Challenges of Maintenance

In this paper, three challenges are identified from the barriers to PSM: practice constraint, advancement constraint, and knowledge constraint.

Practice constraint comes from the barriers of time and opportunity. PEM physicians often have busy work schedules, making it difficult to practice less common but critical procedures during shifts. Additionally, the

rarity of critical procedures limits opportunities to use them. With non-use, skills and procedural knowledge decay at a faster rate than knowledge by a year after training (Perez et al., 2013, p. 20; Yang et al., 2012).

Advancement constraint arises from the barriers of support and time. Rapid advancements can make it difficult for physicians to keep up with the latest techniques and procedures. The tyranny of choice heightens the barrier to entry to these new techniques, especially when tried-and-tested techniques exist and have proven to be reliable. Without departmental support pushing for more experimentation, there is little incentive to develop novel techniques, impeding the advancement of medical knowledge.

Knowledge constraint arises from barriers of support and opportunities. Different healthcare institutions have different critical skills important to the faculty, causing a knowledge disparity between physicians across facilities (Mittiga et al., 2019). With new physicians, proper onboarding is critical in ensuring the same standard of care and level of specialised knowledge. As a result, teaching and maintaining the procedural skills of physicians is an ongoing challenge.

C. Applications in KKH

Firstly, the workflow in KKH targets practice constraints and knowledge constraints. The use of senior physicians as a safety net allows junior doctors to learn and practice procedures on the job (practice constraint) while resolving knowledge gaps as senior physicians provide timely, informative feedback for optimal learning (knowledge constraint) (K. Ericsson et al., 1993, p. 199). Providing the space for junior doctors to learn by trial leads to an increase in performance accuracy while still allowing a safe environment for senior physicians to intervene (Crowe et al., 2018; Docherty-Skippen et al., 2020; K. Ericsson et al., 1993; Firdaus, 2018; Trowbridge & Cason, 1932).

This is seen in how participants understand PSM through technical aspects such as the ability to teach and how competence is operationalised objectively (third-party rating) and subjectively (confidence). Teaching others requires identifying the learner's weaknesses and assigning tasks that build on their pre-existing knowledge for optimal learning. Based on the Levels of Processing Framework, deeper engagement with the material also allows deeper retention of the material for the teacher (Craik & Lockhart, 1972).

Next, the nature of a physician's career relies heavily on competence. Motivating factors such as the desire to provide the best patient care demonstrate advancement constraints as physicians desire to improve their own skill set. However, as a physician's priority is patient care, there is little incentive to explore new treatment options with unknown reliability especially with established treatment options (K. Ericsson et al., 1993, p. 199). Participants are less motivated to explore regional blocks unless it is a department regulation. With more options, physicians tend to fall back on what has been tried and tested, enforcing a mental set as exploring new options that may not succeed could lead to damage to their reputation or hinder patient care.

Finally, the lack of time, manpower, and opportunities is a consistent problem. Most PEM physicians spend their hours tending to patients, leaving little time for courses within stipulated working hours. Attending courses creates a greater workload for other physicians due to a decreased doctor-patient ratio. Rosters to send physicians to courses in a staggered formation have been a common suggestion however, many recognise the difficulties of doing so with limited manpower. As external parties conduct some courses, there is a big pause between their conduct. In-house trainers allow for more frequent conduct due to accessibility. However, the lack of manpower reduces the number of accredited trainers that can facilitate such sessions.

In the short term, current attitudes towards PSM appear to be geared towards crisis management, dealing with the large influx of patients with low manpower. PEM physicians revise only the most essential skills, whittling away those that are less necessary and can be executed by specialists. In the long term, these attitudes could impede innovation as deliberate practice is inherently unenjoyable and requires effort over a long period (K. A. Ericsson, 2004). PEM physicians could display expert mastery over their skills however, they would face difficulties exhibiting eminent performance to make a unique contribution to the field.

D. Practical Recommendations

Hospital administrators can consider extending the practice of enforced protected learning time to all PED physicians, rather than just junior doctors. This protected time could drive autonomous learning through workshops or practice resources. It also enhances proficiency and confidence in real-life procedures while providing opportunities to try novel treatment options and determine their reliability in various contexts. Complementary to this would be promoting self-directed learning. Making available various educational resources such as online modules provide opportunities to enhance

and maintain skills outside of formal training, fostering a culture of life-long learning.

Finally, current workflows should be evaluated with a shuffle in resource allocation to minimise unnecessary administrative work while optimising availability for procedural skill practice. This includes streamlining documentation workflows, re-distribution of non-clinical work, or promoting work-life integration. Support services such as wellness programs and counselling can be extended and promoted. Through this, focus and concentration can be redirected toward performance.

E. Limitations

This study was conducted at a single academic centre with policies, workflows, and culture that may not be generalisable to other academic healthcare institutions. The voluntary nature of participants means that the findings presented might not include all faculty. Future studies can consider a larger and more diverse sample from several hospitals to take this into account. Having a comparison group of Adult Emergency Medicine (AEM) physicians or non-emergency medicine departments could be included in future studies to elicit unique challenges faced by PEM physicians.

V. CONCLUSION

Overall, the themes from the original study largely translate to and are applicable in KKH. SDT concepts are highly applicable in characterising motivation for PSM. Although the scope of autonomy differs, the resultant finding from the current study still utilises its principles. Additionally, the barriers to motivation and skill maintenance hold, allowing for the formulation of practical recommendations to complement the existing framework in KKH.

While findings may not be fully generalisable, they highlight important areas for improvement. Subjective and objective measures of competence highlight the need for evaluating and maintaining competence between various healthcare institutions. Understanding these could allow for policy development to ensure high fidelity of procedural skills. Future research should explore strategies to overcome these barriers and promote effective PSM among PEM physicians.

Notes on Contributors

IT reviewed the literature, conducted, and transcribed interviews, and wrote the manuscript. SG advised the design of the study and interview methods, gave critical feedback on the writing of the manuscript, and sent out invitations to the study. Both authors designed the study,

developed the methodological framework, analysed transcripts, and read and approved the final manuscript.

Ethical Approval

This study was approved by the Ethics Committee of SingHealth IRB (Ref: 2022/2228). All participants have given written consent for their data to be used in the research and for publication.

Data Availability

It is not possible to share data since we did not obtain consent from participants to share all data collected.

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Declaration of Interest

The authors have no potential conflicts to disclose.

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