Original Research

Awareness, Practices, and Experiences of Medical Technology Interns on Laboratory Management: Basis for Biosafety, Biosecurity, and Waste Management in Clinical Setting Amidst the Pandemic

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ABSTRACT

The COVID-19 pandemic highlighted the importance of knowing practices regarding disease prevention, especially among healthcare providers as they are the main group of people most exposed to the global pandemic. This study aimed to assess the awareness and practices of medical technology interns regarding laboratory management, focusing on biosafety, biosecurity, and waste management. Employing a mixed-method approach, the study utilized the Internship Laboratory Management Awareness and Practices Inventory (ILMAPI) alongside semi-structured interviews. The ILMAPI evaluated interns' awareness and practices using multiple-choice and Likert-type questions that have been subjected to item and factor analysis, reliability, and validity testing ensuring its accuracy in assessing the parameters. Fifty interns participated in the study via Google Forms, while 12 engaged in interviews. Descriptive, inferential statistics and thematic analysis were employed for quantitative and qualitative data, respectively. Results revealed varying levels of awareness among interns with biosafety being the most recognized aspect and biosecurity the least. Moreover, despite the moderate level of awareness in waste management, participants were shown to be satisfied with the practice. Qualitative analysis highlighted the significance of awareness and good practices beyond self-protection but also for community health. Overall, the study emphasizes the need to bolster awareness and practices in laboratory management among medical interns to enhance pandemic preparedness and ensure the safety of healthcare workers and community in general.

Keywords: Biosafety, Biosecurity, Waste Management, Awareness, Good Practices

INTRODUCTION

With how COVID-19 has been able to affect the whole world, it has put things into perspective as it showed how vital awareness and good practices are, and how dangerous misinformation could be when it comes to something as serious as a contagious virus.

One of the most exposed sectors to COVID-19 was the healthcare providers as they were the ones directly handling patient samples and caring for the patients themselves. According to WHO

(2021), there are 24,234 healthcare workers that have been positive for COVID-19, 98.1% have recovered while there were 363 active cases in 2021. Unfortunately, there were 104 healthcare workers that have perished because of the virus. This highlights how important biosafety, biosecurity, and waste management is because it is the health workers who are primarily vulnerable to exposure.

At the post-pandemic era, COVID-19 is still prevalent however other laboratory-acquired infections are still commonly occurring and should not be ignored. Laboratory-acquired infections (LAIs) can be due to a wide variety of bacteria, viruses, fungi, and parasites. The precise risk of infection after exposure have not been studied thoroughly but surveys of LAIs show that *Brucella* species, *Shigella* species, *Salmonella* species, *Mycobacterium* tuberculosis, and *Neisseria* meningitidis are the most common causes. However, when it comes to viral infections, bloodborne pathogens are the usual culprit (Weinstein & Singh, 2009).

Consequently, biosafety plays a significant role in circumventing these risks. These health-related threats posed by various biologically hazardous materials handled in the laboratory can be minimized and controlled through the appropriate implementation of nationally and internationally certified protocols. One of these strategies is ensuring that the laboratory staff are educated and trained so that they have an adequate awareness to handle these biologically hazardous materials (Peng et al., 2018). On the other hand, biosecurity is also a key concept in controlling various risks of these biological hazardous materials (Padde et al, 2022). In fact, implementing biosecurity properly in laboratories by establishing protocols on handling and disposing of these biological materials will prevent any accidents of spreading, thus leading to a safe working environment for laboratory personnels and which can extend to the community. Furthermore, waste management is another critical aspect in keeping the laboratory working environment safe by promoting good practices of disposing of biological hazardous materials in the appropriate trash bag (WHO, 2018). Therefore, implementing these laboratory management aspects will allow them to improve the safety of all laboratory personnel and the community's health.

Building a firm foundation of awareness on these facets of clinical laboratory work will ensure better equipped future medical technologists increasing their awareness about the various fields within medical laboratory science, while simultaneously educating them in laboratory risk management.

METHODOLOGY

This study employed a mixed-method research design, integrating both quantitative and qualitative approaches to investigate the awareness, practices, and experiences of medical technology interns regarding laboratory management, focusing on biosafety, biosecurity, and waste management. The pragmatic perspective underlying this methodology emphasizes the richness and depth of insights gained from employing multiple research methods (Sahin & Ozturk, 2019). By adopting a convergent-parallel approach, researchers simultaneously collected quantitative and qualitative data, allowing for the combination and comparison of these complementary data sets on the same phenomena (Edmonds & Kennedy, 2017).

The quantitative component involved a survey questionnaire administered to participants, while the qualitative aspect comprised semi-structured interviews. This methodological framework facilitated a comprehensive exploration of interns' awareness, practices, and experiences in laboratory management.

The study took place in a private educational institution in Manila. It was conducted during the academic year of 2022-2023. The participants who partook in this study are 4th year medical technology interns who are having a clinical internship in the selected higher educational institution. Moreover, the sampling technique used is a non-probability sampling, particularly, purposive sampling. Also known as selective or subjective technique, this sampling chooses samples based on characteristics of a population that is relevant to the objective of the study (Crossman, 2020). The semi-structured interview was conducted until the qualitative data gathered was saturated, making it a quota sampling procedure.

The study made use of a researcher-constructed survey questionnaire named Intern Laboratory Management Awareness and Practices Inventory (ILMAPI), based on the variables that had been identified in this study. The research instruments employed in this study were submitted for content validation. The validators are experts in the field of Medical Technology, Molecular Biology and Biotechnology, and Public Health. Appropriate changes were made based on the suggestion of the content validators.

This survey questionnaire aimed to ascertain the level of awareness and practices of the participants on laboratory management particularly on biosafety, biosecurity, and waste management. To determine the level of awareness of the participants, the researchers used a multiple-choice questionnaire that contains questions regarding the three domains of laboratory management being focused on. Each question had two possible correct answers and participants were allowed to choose every answer they believed to be correct. Correct responses were awarded one point which means that for every item, a participant can be awarded two points.

Subsequently, wrong and “I am not aware” answers would not be awarded any point. For the assessment of their practices on biosafety, biosecurity, and waste management, a 4-point Likert scale questionnaire was utilized. It included choices such as always, often, sometimes, and never. Subsequently, a pilot test was employed to the Intern Laboratory Management Awareness and Practices Inventory (ILMAPI) questionnaire. It was accomplished by administering the survey questionnaire to selected medical technology interns through an online platform, Google Forms, prior to the actual data collection procedure. The participants for this pilot study were given the informed consent form that presented them the benefits and risks of participating in the study. Additionally, it gives them the assurance that the information gathered in the study is treated with utmost confidentiality. The researchers used a semi-structured interview to gather qualitative data from the respondents. Open-ended questions were constructed to analyze their experiences on laboratory management specifically on biosafety, biosecurity, and waste management.

Prior to the data collection, the selected 50 survey participants and 12 interviewees were given an informed consent form. This ensured that the participants were informed of the purpose and aim of the study and the benefits of their participation in the study. Most importantly, it includes a confidentiality clause that protects the data privacy of the participants. The survey aspect of the data collection was conducted through online means via google forms. Participants were provided a link that allowed them to access the survey questionnaire. On the other hand, the interview involved a more in-depth discourse about the topic using semi-structured interview questions. An online platform, google meet, was used as the meeting space for the discussion. With the permission of the participants, the discussion was recorded for analysis purposes.

The quantitative aspects of this study of which the data would be coming from the survey responses was analyzed using statistical tools. The data would be primarily analyzed using inferential statistics. It uses measurements from the sample of subjects in the study and compares them to eventually make generalizations about the larger population of subjects (Moyaho & Beristain-Castillo, 2019).

To extract meaning from the data gathered in the semi-structured interview, thematic analysis was employed. Thematic analysis is an approach that aims to identify patterns across qualitative data sets. It is an analytical method that offers theoretical flexibility making it viable across a range of disciplines (Vaismoradi et al., 2013; DeSantis & Noel Ugarriza, 2000).

RESULTS AND DISCUSSION

Table 1. Demographic Profile of the Participants of the Study who Participated in the Survey

GENDER	FREQUENCY	PERCENTAGE
MALE	14	28%
FEMALE	36	72%
TOTAL	50	100%

Table 1 indicates that there are 14 male participants, accounting for 28% of the total respondents. On the other hand, the 36 female participants make up for the remaining 72% of the responses received from the survey. Additionally, due to the pandemic, all of the participating respondents have only been deployed in one private hospital for the duration of their internship. The participants of the survey were sent invitations to participate in the interview portion of the study. The researchers conducted the interview with those that gave their informed consent, until the data was saturated. Table 2 presents the demographic profile of the interviewees.

Table 2. Demographic Profile of the Participants of the Study who Participated in the Interview.

GENDER	FREQUENCY	PERCENTAGE
MALE	7	58.33%
FEMALE	5	41.67%
TOTAL	12	100%

Table 2 indicates the number of participants who were part of the semi-structured interview conducted for the qualitative data gathering. There were a total of 7 males and 5 females, making up 58.33% and 41.67% of the total number of respondents, respectively. No identified non-interns or interns from other programs were able to

participate in this data gathering, both qualitative and quantitative.

Determining the level of awareness of medical technology interns on laboratory management in terms of biosafety, biosecurity and waste management is one of the primary research objectives of this study. The survey questionnaire given to the participants to assess their level of awareness covered three specific aspects of laboratory management focused. This instrument is composed of 11 questions containing correct and incorrect answers, as well as an "I am not aware option".

Table 3. Itemized Descriptive Statistics for the Level of Awareness towards Laboratory Management.

ITEMS	Means	SD	Rank	Interpretations
1. Where should you store food or drink, or personal items like coats and bags? (A1)	1.14	0.60	5	MODERATELY
2. How should you handle personal items brought inside the laboratory? (A2)	1.18	0.85	4	MODERATELY
3. When should you wash your hands thoroughly with warm running water and soap? (A3)	1.46	0.61	3	HIGH
4. What should you be aware of when handling potentially infectious materials? (A4)	1.7	0.51	2	HIGH
5. How can you minimize the formation of aerosols and droplets when manipulating specimens? (A5)	0.94	0.68	7	MODERATELY
6. What practices should you follow when wearing gloves? (A6)	1.82	0.39	1	HIGH
7. What should you keep in mind when using syringes in the laboratory? (A7)	1.08	0.49	6	MODERATELY
8. What should you consider when revoking access to a member of the personnel? (A8)	0.9	0.58	9	MODERATELY
9. Which of the following does not include the protection of valuable biological materials? (A9)	0.64	0.48	10	LOW
10. What is the role of laboratory personnel as caretakers of valuable biological materials?(A10)	0.6	0.76	11	LOW
11. What information should be in the label of waste bags from laboratories?(A11)	0.92	0.63	8	MODERATELY

***Legend**: 2.0 - 1.35 (High), 1.34 - 0.68 (Moderately), 0.67 - 0 (Low)*

Based on Table 3, it can be gathered that the items for the awareness part of the questionnaire had varying means ranging from 0.6 to 1.82 which indicates that the respondents had a spectrum of awareness when it comes to biosafety, biosecurity, and waste management. Furthermore, A6 recorded the highest weighted mean, 1.82, implying that the medical technology interns who participated in the

study had a high level of awareness regarding the protocol on wearing of gloves when handling specimens. In contrast, the lowest item mean was 0.6 which was for A10. This result suggests that the participants had a low level of awareness of the roles of laboratory personnel as caretakers of valuable biological materials.

Another objective of this study is to determine the practices of medical technology interns when it comes to the three laboratory management aspects. The second section of the survey questionnaire focused on their practices. This section was divided into three domains for encompassing the specific aspects of laboratory management being studied. Each question contained a 4-point Likert scale of options: always, often, sometimes, and never. In table 4, the descriptive statistics for the first dimension is displayed.

Table 4. Itemized descriptive statistics for the dimension biological and chemical agents to access for practices part of the instrument.

ITEMS	Means	SD	Rank	Interpretations
1. Do you segregate the infectious waste and non infectious waste separately in appropriate waste containers? (BCHD 1)	3.9	0.36	2	ALWAYS
2. Do you monitor and enforce the security-related regulations and agreements in your organization? (BCHD 2)	3.4	0.93	4	OFTEN
3. Do you use an appropriate method in disinfecting some infectious waste materials before disposing in appropriate waste containers? (BCHD 3)	3.8	0.45	3	ALWAYS
4. Do you avoid creating splashes and/or aerosols when performing all procedures? (BCHD 4)	3.92	0.27	1	ALWAYS
5. Do you ensure that the lights on buildings at night are functioning properly? (BCHD 5)	3.2	0.88	5	OFTEN
6. Do you check all the cabinets that store all the chemical reagents locked? (BCHD 6)	3.18	0.85	6	OFTEN

Legend: *4.0 - 3.5 (Always), 3.49 - 2.5 (Often), 2.49 - 1.5 (Sometimes) and 1.49 - 1.00 (Never)*

It can be derived from the table above that the mean for every item in the dimension of practices on biological and chemical agents' access is relatively high and ranges from 3.22- 3.62. This denotes that the respondents have good practices when it comes to ensuring that only authorized personnel have access to chemical and biological agents in the laboratory. The highest mean (3.62) is recorded for BCA 1 which implies that the medical technology interns surveyed practices measures to ensure that only authorized personnel have access within the laboratory. Subsequently, although BCA 2 had the lowest mean (3.22) for this dimension, it still signifies positive practices from the interns since it means that they often check all sensors and alarms in case of emergency.

The consequent dimension focuses on the handling and disposal of agents in the laboratory. Table 5 presents the descriptive statistics for this dimension.

Table 5. Itemized descriptive statistics for the dimension Biological and Chemical Agents Handling and Disposal for practices part of the instrument.

ITEMS	Means	SD	Rank	Interpretations
1. Do you make sure that all unauthorized persons are being monitored from entering the authorized laboratory? (BCA 1)	3.62	0.67	1	ALWAYS
2. Do you make sure that all sensors and alarms are functioning properly in case of an emergency or an intruder going inside the building or laboratory? (BCA 2)	3.22	0.93	4	OFTEN
3. Do you make sure that all authorized personnel have access to infectious materials and/or toxins when using them in the laboratory? (BCA 3)	3.42	0.84	3	OFTEN
4. Do you make sure that the access of information related to infectious materials, toxins and/or documentation in computers or networks is strictly controlled and maintained at all appropriate times? (BCA 4)	3.6	0.67	2	ALWAYS

Legend: *4.0 - 3.5 (Always), 3.49 - 2.5 (Often), 2.49 - 1.5 (Sometimes) and 1.49 - 1.00 (Never)*

Table 5 shows that the data gathered of the items on biological and chemical agents handling and disposal have a relatively high mean that ranges from 3.18 3.92 which represents that the respondents have good practices in handling biological agents and waste management in the laboratory. As depicted in the table above, BCHD 4 had the highest mean (3.92) which denotes that the medical technology interns ensure the prevention of any incidents or accidents while performing laboratory procedures inside the laboratory. On the other hand, BCHD 6 had the lowest mean (3.18).

The descriptive statistics for the last dimension which focuses on the monitoring of laboratory agents is presented in Table 6.

Table 6. Itemized descriptive statistics for the dimension Biological and Chemical Agents Monitoring for practices part of the instrument.

ITEMS	Means	SD	Rank	Interpretations
1. Do you ensure that the access control to electronic devices is strictly monitored? (BCM 1)	3.34	0.85	2	OFTEN
2. Do you ensure that you properly check all infectious materials and/or toxins are destroyed? (BCM 2)	3.36	0.83	1	ALWAYS

Legend: *4.0 - 3.5 (Always), 3.49 - 2.5 (Often), 2.49 - 1.5 (Sometimes) and 1.49 - 1.00 (Never)*

Table 6 shows the items of the practices on the dimension of biological and chemical agents towards monitoring which has a mean that ranges from 3.34- 3.36. This denotes that the participants have good practices when ensuring the safety of all infectious materials and/or toxins inside the laboratory. This suggests that the medical technology interns have been performing measures to ensure that all infectious materials and/or toxins inside the laboratory are safe and secure before and after use. Consequently, it also implies that electronic equipment/devices used in laboratories are inside the monitored strictly in prevention from being accessed by unauthorized personnel.

Another objective of this study is to investigate the relationship between gender and the level of awareness and practices of medical technology interns on laboratory managements in terms of biosafety, biosecurity, and waste management. To determine if there is a significant difference between the level of awareness and practices of the male and female participants, the researchers used t-test. Table 7 summarizes the t-test results for this objective.

Table 7. Summary of T-Test results for the Awareness and Practices Variables.

'ariable	t-test for Equality of Means			
	t	df	p	Interpretation
reness	-0.265	48	0.792	Accept null hypothesis
tices	-0.025	48	0.980	Accept null hypothesis

dence Interval = 0.05

In Table 10, the t-value indicated for Awareness is-0.265 while the p-value is 0.792. Since the t-value is less than the p-value, the null hypothesis is accepted. This means that across the male and female respondents, there is no significant difference in their level of awareness with regards to biosafety, biosecurity and waste management. Likewise, the results of the t-test for the Practices variable is also depicted in the table. The t-value

computed for this variable is-0.025 while the p-value is 0.980. Similarly, the t-value is less than the p-value, hence, the null hypothesis is retained. This result indicates that there is no significant difference between the male and female medical technology interns' practices when it comes to laboratory management. To summarize, both of the null hypotheses of the two variables failed to be rejected.

The semi-structured interview allowed for the researchers to gather information and narratives from the respondents on their experiences on laboratory management in terms of biosafety, biosecurity, and waste management. Through thematic analysis, three primary themes have emerged from the statements of the interviewees.

Establishing Good Practices in biosafety, biosecurity, and waste management: towards addressing the gaps during pandemic response.

Throughout this hardship that was the COVID-19 pandemic, aside from the shortage of physical supplies, the most severe scarcity was of qualified, trained staff who are knowledgeable in biosafety measures (Gillum et. al., 2022).

Based on the responses of the participants, it was apparent that the practice of biosafety measures has played a significant role in their experiences within the hospital as a medical technology intern. As depicted below: “I don’t bring my things to micro or any sections because we are always practicing universal precautions because it is a hospital setting and you are dealing with legit specimens.” (R8)

Laboratories deal with complex and time-consuming workload. Efficiency is a must in order to get all of the tasks accomplished accurately.

Aside from biosafety, biosecurity is also significant in mitigating any bio risk in laboratories. According to the WHO (2006), biosecurity measures focus on enhancing the protection, control, and accountability for valuable biological materials within laboratories for the purposes of preventing unauthorized access, loss, theft, misuse, diversion or intentional release. The participants also shared how biosecurity measures were implemented in the hospital they were deployed in and what has been their role in upholding these measures as evidenced by this statement:

“There are certain areas that even us interns are not allowed in. Like the molecular laboratory, it requires a keycard so no one can come in without permission.” (R11)

Based on their shared experiences, as they are not licensed professionals yet, even interns are restricted to perform and enter some areas of the laboratory. This is usually both for their safety and the sensitivity of the information within the hospital.

The last element of this laboratory bio risk management triad is waste disposal. Ultimately, this part of the triangle does not solely rest upon medical technologists and interns, however, it starts with them. During the interviews, the respondents have shared the following experiences related to this:
“The infectious ones are in the yellow bag but the sharps like the inoculating loop, they are separated, they have a puncture resistant container.” (R2)

The interviewees shared how accountability measures are implemented during their internship:

"If they find out that you dispose of your waste incorrectly, you will automatically receive a demerit." (R2).

As stated by the participants, a merit and demerit system is in place for the staff to ensure that the interns follow the correct practices within the laboratory. Any mistake that they commit will result in them receiving a demerit.

From Student to Intern: Hurdles faced in shifting from school-based to hospital-based laboratory management.

Based on the thematic analysis performed on the interview responses, the second theme that has emerged focuses on the transition of the respondents from student to interns. Participants recounted initial struggles they went through as well as the impact their internship program had on their level of awareness and practices towards laboratory management.

The medical technology interns that participated in the study have experienced a transitional shock which, based on their narratives, stem from low confidence making them hesitant to work in the laboratory. This statement from an interviewee reflects these initial struggles:

"At first, it was like I was scared to take action in the laboratory, since I didn't know what I'm doing because I didn't experience it in person before I was deployed for an internship." (R11).

Apart from the challenge the participants faced at the beginning of their internship, their narratives also revealed another hurdle that they struggled with, the gaps in their level of awareness and hands-on experience in good practices regarding biosafety, biosecurity, and waste management. Most of the respondents ascribed this lack of awareness and experience to the onset of online classes during their third year proper where they were supposed to gain the skills needed to prepare them for the internship program. This interview statement supports this:

"There are things that in general, the tasks in the lab that weren't taught to us because of the pandemic since we were doing online classes. That is what has been difficult for me." (R9).

Eventually, these inadequacies in the awareness level and hands-on experience of the medical technology interns resulted in some errors that they committed while working in the laboratory they were assigned in.

From the interview transcript, the researchers were able to extract participant utterances to corroborate these results:

"We are shaken up when it is busy… as an intern, working during those times, we have to have a presence of mind." (R2)

Despite the challenges and blunders the respondents have encountered, ultimately, they claimed that their internship experience has had a huge impact on their level of awareness and practices when it comes to laboratory management. In their narratives, they credited their development to the approach of teaching in the hospital setting, as well as the willingness of their staff to inculcate to them the correct practices they must have inside the laboratory.

"There is a big impact when we became interns there because we learned a lot, we were able to absorb what they were teaching because they say it verbally, they demonstrate it." (R2)

Championing Public Health

The importance of awareness and practices on good laboratory management Medical technologists are considered to be champions of public health because of the role they play in promoting and protecting the health of the people and the community. As such, one of the themes that has risen from this qualitative data gathering focuses on the importance of awareness and good practices on laboratory management in upholding public health. The importance of minimizing bio risk has drastically increased in recent years due to the pandemic because of its role in mitigating the spread of disease not only to those who handle biological agents directly, but also to the community. The participants of the study have the same perception on how awareness and good practices regarding this triad is important in managing bio risk.

"There is a big impact regarding the awareness of a medical technologist towards those three… because if they don't follow one of them, it is either he or she will be harmed or worse the community." (R8)

However, there are also participants that chose to highlight the importance of awareness and practices on their future career as medical technologists. They saw how developing their level of awareness and practices during their internship can make them more effective in their future endeavors in the field of public health.

"You already know the right flow within the hospital, if you make a mistake in those three [biosafety, biosecurity, and waste management] at the beginning, everything is affected, you have to be mindful or alert especially when it's toxic" (R2).

DISCUSSION

With the emergence of COVID-19 for the last few years, even now, still in the post-Pandemic era, it continues to persist and has been part of the lives of countless people globally. This unique phenomenon helped us appreciate how vital awareness and good practices are during the pandemic, and how one must provide accurate and precise information pertaining to serious problems such as contagious viruses.

This study has been conducted to determine the awareness, practices, and experiences of medical technology interns on laboratory management, particularly on biosafety, biosecurity and waste management in the clinical setting amidst the pandemic.

Through the data gathered that underwent analysis the medical technology interns showed varying levels of awareness on biosafety, biosecurity, and management. Biosafety appears to be the aspect of laboratory management that they are most highly aware of while biosecurity is somehow the area of laboratory management they are least aware of. Moderate level of awareness was observed in waste management. However, when it comes to practices, the participants demonstrated satisfactory practices among the three domains, as reflected in the quantitative data. When determining whether there is a significant difference in the level of awareness and practices between the two genders, it was revealed

that there is not a significant difference between the two samples. This means that gender does not discriminate the level of awareness and practices the participants had. Subsequently, it also appears that among those three dimensions of practices, the medical technology interns have shown that there was no significant difference between genders. This might have been because both have received the same school-based and hospital-based learning and experiences on the aspects of laboratory management respectively.

Additionally, three themes based on the experiences of the medical technology interns regarding biosafety, biosecurity, and waste management that were obtained from the respondents. Establishing good practices in biosafety, biosecurity, and waste management: towards addressing the gaps during pandemic response has been one of the highlights of their experience in the laboratory. They recounted the specific measures that they implemented as medical technology interns. Additionally, the researchers recognized from their statements the hurdles the participants had to overcome to be able to successfully transition from student to intern. In which they discussed the initial struggles they faced as well as the mistakes they have made at the beginning of their journey. Ultimately, as they metamorphosized into a well-developed intern, they reflected on the importance of being aware and having good practices regarding laboratory management in not just protecting themselves.

Through the findings this study was able to extract, the researchers are aiming to provide a basis for biosafety, biosecurity, and waste management in the clinical setting amidst the pandemic with the perspective from medical technology interns. Educational institutions may utilize this to formulate an internship program focusing on equipping future healthcare workers with a firm foundation that will make them exemplary champions of public health.

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