

# The Development of a Local Sexual Assault Investigation Kit: The Philippine Experience

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## ABSTRACT

**Objectives.** This paper presents the development of a local sexual assault investigation kit (SAK) that doctors in the Philippines could use to collect biological samples from victims of sexual abuse, including child patients, that would be used for DNA testing. The study also reports on a management system via courier service to protect the integrity of the samples that could be eventually used as evidence in court from the collection site to the laboratory with sufficient backup measures.

**Methods.** Women and Child Protection Units (WCPU) from Manila, Baguio, Cebu, and Davao partnered with the DNA Analysis Laboratory, Natural Sciences Research Institute of UP Diliman (NSRI-UPD) DNA Analysis Laboratory in testing the utility of a prototype SAK for the collection of biological samples from child patients. From January 2002 to March 2006, samples were collected from patients who went to WCPU within 72 hours post-contact and consented to participate in the study. WCPU doctors collected biological samples guided by the patient's narratives and packaged the samples while following detailed documentation and chain of custody procedures. SAKs were then sent via a designated courier service from WCPU to the NSRI-UPD DNA Analysis Laboratory for DNA testing. The WCPU kept half of the samples collected, following recommendations made during sectoral consultations that included members of the Research Group of the Philippine Judicial Academy, prosecutors, and defense counsels. Case samples were packed well by the WCPU and received at the NSRI-UPD DNA Analysis Laboratory. Due to budget limitations, only the internal genitalia and patients' reference buccal swabs were subjected to DNA tests as reported by Maiquilla et al.<sup>1</sup> The remaining SAK components and case records were kept in a dedicated and secure storage facility. DNA testing reports were sent to the WCPU, which released them to the child patients and their legal guardians.

**Results.** One hundred fifty-four female children aged 2-18 years old and their legal guardians agreed to participate in the study. Based on the initial interviews of the social workers who conducted the evaluation, all the participants came from families with very low socioeconomic status. The WCPU doctors then complied with prescribed procedures. To date, NSRI-UPD DNA Analysis Laboratory records show that a subpoena for expert testimony had been issued in only one case out of the 63 cases (1.6%) that were positive for male DNA. No further information was available on the final decision in this case due to the absence of any order from the judge granting the laboratory access to court records. Likewise, WCPUs did not have any information on the remaining 62 cases that could have used the DNA test results as evidence if a case had been filed in court.

**Conclusion.** This study is the first to report the development and validation of a sexual assault investigation kit in the Philippines aimed at helping medical doctors in collecting and preserving critical biological samples for DNA testing. Using a dedicated courier service to send SAK from collecting agencies to the laboratory for DNA testing was successfully tested and resulted in faster delivery and significantly reduced overall cost. While DNA testing remains the most powerful tool for human identification and the technology has been available in the Philippines

since 1997, certain factors have prevented it from being used routinely in sexual assault investigations, including those involving children.

**Keywords:** sexual assault investigation kit, forensic DNA testing, women and child protection units, sexual violence

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## INTRODUCTION

Since 1997, Women and Child Protection Units in the Philippines (WCPU) have received patients who have shown signs of sexual abuse.<sup>2</sup> The original unit was located at the Philippine General Hospital of the University of the Philippines (UP-PGH), which had 374 child patients in its first year. Since then, the number of patients served has steadily increased as more WCPUs have been established in different regions. At the end of 2019, 113 WCPUs covering 57 provinces and ten cities have reported 10,049 cases against children, with 66.71% or 6,704 cases involving sexual abuse. Most of the perpetrators were persons known to the victim. In the case of children, many of these perpetrators have some form of authority over them, e.g., father, uncle, or stepfather, making prompt reporting challenging because of the child's fear for their safety coupled with their financial dependence on the perpetrator.<sup>2</sup>

If child patients file cases in court, one major area of concern is that Philippine courts rely heavily on testimonial evidence. Appearing in court causes additional trauma to child victims who have to recount their ordeal in prolonged litigations that can often take many years. The lengthy process also causes emotional and economic burdens on prospective litigants, many of whom do not have the financial resources to support their cases. On the other side of the coin, cases of wrongful convictions based primarily on the victim's testimonial evidence have also been reported.<sup>3-5</sup> Either way, prolonged litigation has resulted in the overcrowding of Philippine city and provincial prisons, with occupancy levels as high as 463.6%, the second-highest number below the Republic of Congo.<sup>6</sup> Hence, there is an urgent need for reliable tools to assist investigations and provide objective scientific evidence to support or negate testimonies in court.

With the rapid advancement of forensic DNA technology, DNA analysis of biological samples offers an additional tool for forensic investigations. DNA testing results are used to identify the human sources of biological samples and enhance public safety by removing offenders from the community until these persons are rehabilitated.<sup>7</sup> Moreover, in countries like the Philippines, where a trial can take from three to five years on average for a single case,<sup>8</sup> the overall savings to the government of faster and more accurate investigations, expedited trials, and decreased jail population far outweighs the monetary cost of DNA testing.<sup>1</sup>

In sexual assault cases, the intimate physical contact between victim and assailant provides ample transfer of biological material for forensic DNA analysis. DNA testing requires collecting, handling, storing, and turnover of biological samples from WCPU and other hospitals to a DNA testing laboratory. The Philippines presently has three government institutions with in-house DNA laboratories to aid sexual assault investigations. These are the Philippine National Police (PNP), with its crime laboratories in Camp Crame, Quezon City, and regional offices in Cebu

and Davao; the National Bureau of Investigation (NBI) in Manila; and the University of the Philippines through the NSRI-UPD DNA Analysis Laboratory in Quezon City. The majority of criminal cases are handled by the PNP and NBI laboratories. The NSRI-UPD DNA Analysis Laboratory primarily conducts forensic genetics research and provides DNA testing services when ordered by the courts. Because of the transient nature of the perpetrator's DNA that had been transferred to the body and personal items of the victim, as well as the critical need to document the entire process of collection, the use of a sexual assault investigation kit (SAK) is highly recommended.<sup>7</sup> Since the availability of a validated prototype kit, the Committee on Women and Child Protection Program had suggested that these kits be made available to all WCPUs in the Philippines.<sup>2</sup> Notably, there were female and male children patients examined by WCPUs consistent with the study of Ramiro et al. that reported 6% of women and 4.5% of men had experienced sexual abuse during the first 18 years of their lives.<sup>9</sup> Since male children are also victims; the SAKs must also cater to the types of physical contact and the complexity of abuse they experience.

SAKs, or 'rape kits' once known, were first developed in Chicago by Martha Goodard.<sup>10</sup> She came up with the concept of a kit stocked with swabs, vials, and instructions that would help hospital personnel properly collect samples and then turn over these samples to the police. Goodard, a women's civil rights activist, realized the urgency in providing medical doctors and hospital workers with a tool to collect samples promptly and properly from patients who showed signs of sexual assault. At the time, some nurses would have women wash before physical examination and dispose of their bloodied clothes, thereby losing the most important pieces of physical evidence to support the claim of sexual assault. In some cases, the police would no longer pursue an investigation after receiving 'rubber-banded unlabeled slides' from a hospital which had become useless because of the lack of markings to distinguish evidence from different victims and the cross-contamination resulting from improperly handled specimens. This concept of a rape kit was later used by Sgt. Louis Vitullo of the Chicago crime laboratory for his "Vitullo Evidence Collection Kit" that was launched in the US in January 1979 as the first rape kit.<sup>10</sup> After the initial launch, the kit was promoted by Goodard and her colleagues all over the US. The use of the kit led to an increased awareness of the impact of a proper evidence-based sexual assault investigation on a successful prosecution.<sup>11</sup> Over time, the rape kit became known as the SAK, following the names and definitions included in the 2018 report of Cook, Cortina, and Koss.<sup>12</sup>

The mishandling of sexual assault evidence in the US was not that much different from the Philippine experience. There have been well-documented cases where biological evidence had been lost or destroyed.<sup>13,14</sup> Before the local prototype kit reported here, WCPUs had to import SAKs or assemble one using available laboratory consumables.

The material cost was an issue in most units, many of which did not have a dedicated budget for handling patients who may have experienced some form of sexual violence. There were instances when samples could not be collected from patients because of the unavailability of swabs, labels, and documentation material to guide medical doctors through the process. When some hospitals were able to collect biological samples from victims immediately post-contact, the lack of funding for DNA testing resulted in numerous untested body swabs stored in conditions that were not ideal for preserving biological evidence. Therefore, a cost-effective, locally produced SAK was needed to help medical doctors collect samples from patients, especially child patients, who showed signs of sexual abuse. This paper presents the development of a local SAK that all WCPUs and hospitals could use to collect biological samples as part of sexual assault investigations. We also report here the secure transport of evidence via a dedicated courier service from regional clinics to a DNA laboratory following the chain of custody requirements of the Supreme Court for evidence, including DNA evidence.

## METHODS

### Consultations with WCPUs, lawyers, and courier services

The NSRI-UPD DNA Analysis Laboratory worked with WCPU doctors to define the components of a local SAK. The significant factors that were considered included 1) minimizing trauma to the patient while obtaining the biological samples for future DNA analysis; 2) ease and efficiency of sample collection and thorough documentation; 3) chain of custody principles from collector to courier service that would provide secure transport of the samples to a DNA testing facility, and 4) low overall cost.

Pre-validation consultations were also held with medico-legal and law enforcement groups, lawyers, judges, including members of the research group of the Philippine Judicial Academy. The kit was presented as part of a proposed efficient and cost-effective strategy for collecting, transporting, and analyzing sexual assault DNA Evidence.

Courier companies that could provide secure transport of samples were invited to participate and discussed their internal system of moving materials from source to destination. The social and legal value of the samples as potential evidence in a criminal investigation was emphasized. One courier company that expressed its willingness to participate was selected.

### Sample collection

Validation of the system was conducted on 154 child cases from January 2002 to March 2006. Prototype SAKs were assembled by the NSRI-UPD DNA Analysis Laboratory and sent to the participating WCPUs. The WCPUs of UP-PGH collected samples in Manila, the Baguio General

Hospital and Medical Center in Baguio City, the Vicente Sotto Memorial Hospital and Medical Center in Cebu City, and the Davao Medical Center in Davao City using a prototype SAK.

Female patients who had sexual contact with their abusers within 72 hours before the medical examination were invited to participate. Patients and their legal guardians provided their informed consent to participate in the study.

WCPU used forms included in the SAK to document patient history during the interviews preceding the medical examination. The child's narrative, the timeline of the abuse, and the SAK instructions guided the WCPU doctors to determine which body surfaces were to be swabbed in addition to the internal and external genitalia, anus, and oral cavity. At least two to four swabs were collected per body surface. For children below eight years old, calcium alginate swabs were used to reduce the pain and trauma experienced by the patient.<sup>15</sup> WCPUs performed light microscopy to detect the presence of sperm in 109 (70.8%) of the cases. The patients' underwear immediately post-contact or those that may have samples from the perpetrator were also collected. Samples were labeled, air-dried, and stored at 4°C, following the instructions that were included in the kit.

The first 114 cases were picked up from UP-PGH using a government vehicle. Samples in the remaining 40 cases originating from Baguio, Cebu, Davao, and Manila were sent to the NSRI-UPD DNA Analysis Laboratory via a courier service. Whenever possible, half of each sample type remained stored at the source WCPUs as a backup.

### Inspection of SAKs before DNA testing

Upon receipt by the NSRI-UPD DNA Analysis Laboratory, a detailed inspection of the kit and photo documentation was done. Before opening the package, SAKs were inspected for any external damage or sign of tampering. If there were any, the laboratory would not have accepted the package, and following standard operating procedures, would have immediately contacted the source WCPU. If no such damage or tampering were detected, the person receiving the package from the courier would have signed a chain of custody form acknowledging the date and time of transfer, the source, recipient, and description of the package. This chain of custody form contains information on the SAK's storage location, people who had access, and the state of the SAK after it was picked up from the WCPU of origin, through to the courier service, and until it finally reached the laboratory.

Kits were opened and inspected to determine 1) the number, types, and state of samples submitted to the laboratory; 2) relevant information provided by the child patient in the sample collection form; and 3) the collector's adherence to SAK instructions. The kit was assigned a case code, and samples were labeled with specific sample codes. Clothing and underwear were stored dry and carefully packed in clean paper at room temperature, whereas all other body swabs were stored at 4°C.



## Sample processing and Y-DNA testing

Vaginal swabs were processed and reported.<sup>1</sup> Briefly, DNA from vaginal swabs was extracted using a standard organic procedure.<sup>15,16</sup> DNA samples were amplified in duplicates using the PowerPlex® Y multiplex kit (Promega Corp., WI, USA) following the manufacturer's protocols. The PowerPlex® Y multiplex kit targets male-specific DNA located in 11 Y-chromosomal locations, namely DYS391, DYS389 (I) and (II), DYS439, DYS438, DYS437, DYS19, DYS392, DYS393, DYS390, and DYS385 a/b.

A negative control consisting of sterile water and a positive DNA control with a known genotype were co-amplified with the patients' samples to check for contamination, and quality of amplification, respectively.

The NSRI-UPD DNA Analysis Laboratory released the DNA test results to the relevant source WCPUs. The source WCPUs communicated the DNA findings to their patients. WCPUs were provided with the DNA Manual to help doctors and patients understand the DNA test results.<sup>17</sup>

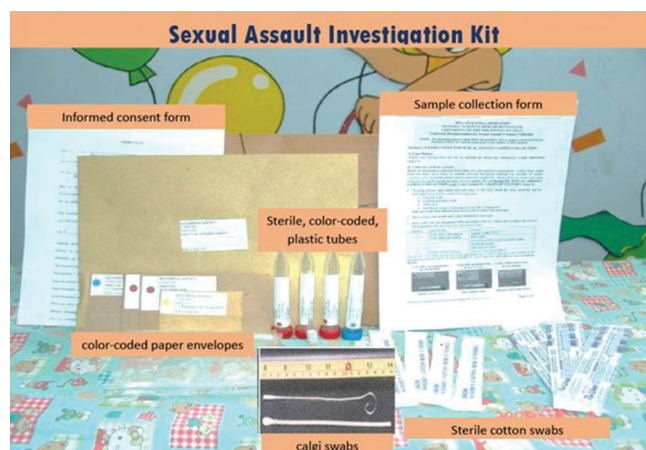
## RESULTS

During the different stakeholders' consultations, four fundamental principles were repeatedly discussed. These principles were 1) the value of preserving the evidence, including the narratives of the incident with the least trauma to the patient; 2) collection and documentation processes must be facilitated for doctors who face many demands for their time while in the hospital; 3) low cost of the kit and the entire process of collection, handling, storage and shipment which the hospital will cover since most patients would be unable to pay; and 4) the importance of ensuring the integrity of all samples by maintaining an unbroken chain of custody required for the admissibility of DNA evidence in Philippine courts. These principles were carefully considered in assembling a prototype SAK.

The Philippine SAK included interview forms, instruction sheets, and checklists, swabs for collecting evidence, such as body swabs (vaginal, anal/perianal, and oral swabs), and foreign material detected on the patient's body during examination (dried secretion, loose hair, vegetation), containers and labeled envelopes (Figure 1).<sup>1</sup> The components in the SAK follows recommendations of the US Department of Justice.<sup>18</sup>

An interview form containing the case history was also included. The information on 1) incident time and location; 2) nature and extent of the abuse; and 3) the identity, number, and relation of the abuser to the patient are essential not only for the management of the patient's case but also for the planning of the type of DNA analysis to be conducted. The most common answers were provided in the forms so that the user could tick the appropriate box during the interview (Figure 2).

Each kit contained instructions on the number and types of swabs to be collected (Figure 3). Generally, the most



**Figure 1.** Components of the prototype sexual assault investigation kit that was developed and validated locally.

critical samples that must be collected were vaginal swabs. Two types of oral swabs were collected depending on the patient's narrative surrounding the assault. An initial oral swab was taken if the patient was directed to perform oral sex. After rinsing her mouth, a subsequent buccal swab was again obtained, but the goal in the second collection was to get the patient's reference sample that would be used to generate her DNA profile. Additional body swabs were included in the kit to collect samples from body surfaces that may contain the perpetrator's DNA. The medical doctors decided on the type and extent of swabbing on these surfaces based on the patient's narrative. Multiple swabs were collected per site (Figure 3): 1) to maximize the amount of sample collected, and 2) the number of swabs was divided into two for the WCPU to retain half the kit components as a backup. The retention of half of the SAK in the source WCPU was a requirement from the prosecutors and members of the Research Team of the Philippine Judicial Academy. Because the use of a courier service for transporting evidence was proposed to reduce cost, lawyers were concerned about the potential loss of samples during transport. The backup samples may also be used if the court orders a second DNA test.

The patient's underwear and clothing were submitted if these had been in contact with the perpetrator or worn by the child-patient immediately post-contact. After sample collection, all components were air-dried to reduce the possibility of microbial growth from damp clothing and swabs. Instructions on how this should be done were included in the information sheets.

A color-coding system was adopted wherein envelopes were provided with tags consistent with the colors of the tube covers used to hold specific sample types (Figure 1). For example, vaginal (internal genitalia) swabs would be placed in blue-capped tubes that would, in turn, be placed in a blue-coded paper envelope. The blue-coded envelope had a label that the collector must fill to indicate the type of swab

REFERRING AGENCY: _____ CASE NO. _____	DAL CASE NO. _____
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**DNA ANALYSIS LABORATORY  
NATURAL SCIENCES RESEARCH INSTITUTE  
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**Casework Documentation for Sexual Assault Evidence Collection**

**Section I. SEXUAL ASSAULT CASE HISTORY**

**A. Victim**  
 Name: \_\_\_\_\_ Gender: \_\_\_\_\_ Age: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**B. Incident of sexual assault**  
 Most recent: Date \_\_\_\_\_ Time \_\_\_\_\_  
 Place of occurrence (address): \_\_\_\_\_  
 Type of environment: ☐ indoor ☐ outdoor specify: \_\_\_\_\_  
 Ejaculation:  
☐ internal (vagina) ☐ external (labia) ☐ none ☐ others \_\_\_\_\_  
 Microscopy:  
☐ + for sperm ☐ - for sperm  
 Post-coital washing:  
☐ Yes ☐ No  
 History of sexual contact within 3 days before and 3 days after the sexual assault incident:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**C. Suspect(s)**  
 Number of suspects: \_\_\_\_\_

Name	Relationship to victim				
1.	<input type="checkbox"/> father <input type="checkbox"/> stepfather	<input type="checkbox"/> brother <input type="checkbox"/> stepbrother	<input type="checkbox"/> uncle <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> grandfather <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> unknown <input type="checkbox"/> others _____
2.	<input type="checkbox"/> father <input type="checkbox"/> stepfather	<input type="checkbox"/> brother <input type="checkbox"/> stepbrother	<input type="checkbox"/> uncle <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> grandfather <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> unknown <input type="checkbox"/> others _____
3.	<input type="checkbox"/> father <input type="checkbox"/> stepfather	<input type="checkbox"/> brother <input type="checkbox"/> stepbrother	<input type="checkbox"/> uncle <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> grandfather <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> unknown <input type="checkbox"/> others _____
4.	<input type="checkbox"/> father <input type="checkbox"/> stepfather	<input type="checkbox"/> brother <input type="checkbox"/> stepbrother	<input type="checkbox"/> uncle <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> grandfather <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> unknown <input type="checkbox"/> others _____
5.	<input type="checkbox"/> father <input type="checkbox"/> stepfather	<input type="checkbox"/> brother <input type="checkbox"/> stepbrother	<input type="checkbox"/> uncle <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> grandfather <input type="checkbox"/> paternal <input type="checkbox"/> maternal	<input type="checkbox"/> unknown <input type="checkbox"/> others _____

Figure 2. Case history section of the sexual assault investigation form.

**Section III. SEXUAL ASSAULT SAMPLE COLLECTION**

**A. Date and Time of Sampling** \_\_\_\_\_

**B. Biological samples (Four (4) samples for each available type):**

1. Body samples (swabs) check the cap colors

☐ Vaginal: number of swabs: \_\_\_\_\_ (into blue cap 15 mL tube)

☐ External genitalia (Labia majora): number of swabs: \_\_\_\_\_ (into red cap 15 mL tube)

☐ Anal: number of swabs: \_\_\_\_\_ (into red cap 15 mL tube)

☐ Oral/throat: number of swabs: \_\_\_\_\_ (into red cap 15 mL tube)

☐ Other types of swabs: number of swabs: \_\_\_\_\_ (into red cap 15 mL tube)  
Part swabbed: \_\_\_\_\_

☐ Other types of samples: specify number, type of sample(s) and description:  
\_\_\_\_\_  
\_\_\_\_\_  
(into Manila envelope and/or coin envelope)

2. Reference samples (victim)

☐ Oral swab: number of swabs: \_\_\_\_\_ (into 1.5 mL or small tubes)  
Note: Prior to collection of reference oral swab sample, have the victim rinse mouth with water.

**C Sample storage:**

Location : ☐ Refrigerator ☐ Room ☐ Other \_\_\_\_\_  
Note: Samples are preferably stored in refrigerator

**D. Biological sampling conducted by:**

Name and Signature: \_\_\_\_\_ Date: \_\_\_\_\_  
Gender: ☐ Male ☐ Female

**Figure 3.** Sample Collection Form which facilitated the documentation of types and number of samples collected.

placed inside the tube. This system served as a mechanism for the doctor and laboratory personnel to check whether the collection process had been properly documented.

Following the chain of custody (COC) requirements from the Supreme Court decision in *People vs. Gerrico Vallejo*,<sup>19</sup> commonly referred to as the Vallejo doctrine, two copies of the chain of custody forms were included per kit. The first COC form was used to document the samples' location, the state in the WCPU from the collection, handling, and temporary storage of samples before the components of the SAK were packaged. The second COC form contained the information of the identity of all handlers from the storage, transport, and final receipt of the SAK at the NSRI-UPD DNA Analysis Laboratory (Figure 4). Once received, the NSRI-UPD DNA Analysis Laboratory used its internal form to document the chain of custody of samples throughout the analysis.

SAKs were successfully air couriered from the WCPUs of the Baguio General Hospital and Medical Center, the Vicente Sotto Memorial Hospital and Medical Center, Davao Medical Center, and the PGH to the NSRI-UPD DNA Analysis Laboratory. All 154 SAKs showed unbroken chains of custody from collection to the NSRI-UPD DNA Analysis Laboratory. Further inspection showed few discrepancies or missing case information. These discrepancies were addressed by contacting the source WCPU for the missing information. Instructions and forms were modified based on the feedback provided by the WCPUs.

Anonymized information and DNA testing results for all 154 cases had been reported.<sup>1</sup> Briefly, male DNA was detected in 63 female patient cases (41%) compared to the positive microscopic detection of sperm cells in 23 out of 109 (21%) cases that were examined.<sup>1</sup>

CHAIN OF CUSTODY FORM					
Date/ Time	Method of Delivery	Released by:	Received by:	Witnessed by:	Comments
		Signature	Signature	Signature	
		Printed Name	Printed Name	Printed Name	
		Designation	Designation	Designation	
Date/ Time	Method of Delivery	Released by:	Received by:	Witnessed by:	Comments
		Signature	Signature	Signature	
		Printed Name	Printed Name	Printed Name	
		Designation	Designation	Designation	
Date/ Time	Method of Delivery	Released by:	Received by:	Witnessed by:	Comments
		Signature	Signature	Signature	
		Printed Name	Printed Name	Printed Name	
		Designation	Designation	Designation	

**Figure 4.** Chain of custody form which must be used to record the times, dates and persons who had access and handled the samples included in the kit.

## DISCUSSION

DNA forensics has opened novel ways to improve sexual assault investigations in the Philippines. However, to conduct DNA tests, biological samples must be systematically collected from the victim's body to prevent the loss of the perpetrator's DNA. Use of the forms included in the SAK facilitated the doctors taking of the patient's history. It

assisted in determining if additional samples should be obtained based on the patient's narrative. Color-coding of sample containers and labels provided a system for sample collection when a doctor needs to simultaneously offer medical care to a victim who may be traumatized because of the recent violence she experienced. The use of tick-boxes for documentation and labeling whenever possible allowed the doctor to devote more time and attention to the patient.



Using DNA technology, samples collected from a victim's body, personal clothing, or material used during or at the time of the abuse would likely contain the perpetrator's DNA. Because of the intimate contact between perpetrator and victim, Locard's Exchange Principle is critical in sexual abuse cases.<sup>20</sup> Although only vaginal swabs were tested during the validation phase, 63 female patients, including a 3-year-old child, were positive for male DNA found solely on the Y-chromosome.<sup>1</sup> This case was crucial because the complete 11 Y-DNA profile generated was a strong tool to identify the perpetrator, which the very young victim could not do verbally. Three other male DNA profiles were generated from samples of female children aged 4-6 years old, showing that a calcium alginate swab can be used for children younger than seven years old and still get enough DNA for testing. This swab that is softer than the standard version is more tolerable for very young children.

Analyzing DNA mixtures is one of the most challenging samples for DNA testing, especially when handling children's cases. Sufficient high-quality DNA from the perpetrator is difficult to recover if the victim is anatomically smaller, if the victim has washed post-contact, or if the reporting of the incident had been delayed, thus increasing the likelihood of sample contamination and DNA degradation. In this dataset, 34 of 43 cases involving 2- to 12-year-olds (79.1%) did not have a Y-DNA typing result compared to the 57 negative results of 111 cases with 13-18-year-old patients (51.3%). In addition, Y-DNA was not detected in more cases involving children who washed themselves post-contact (64.3%) than those who did not (50.8%).<sup>1</sup> Hence, there is a need to inform first responders, e.g., barangay health officials, social workers, local police, teachers, school health personnel, and guidance counselors, of the urgency of bringing a potential child victim to the WCPU as soon as possible.

The tropical and humid climate in the Philippines must also be considered because it promotes microbial activity, including nuclease activity in biological samples that had not been handled and stored properly. Hence the instructions provided in the SAK recommended the refrigerated storage of all swab samples (4°C). Clothes and underwear submitted as part of the SAK were air-dried at room temperature and adequately packaged inside a brown envelope while avoiding contact with other material to prevent contamination. Upon receipt, the NSRI-UPD DNA Analysis Laboratory ensured that the clothes were stored dry in an air-conditioned and secure physical storage facility. The 154 SAKs remain stored in the same facility, pending court directives, requests from the source WCPU, or child patients for additional processing or turnover to the court or law enforcement agencies. It is worth noting that these SAKs had been stored for more than 15 years within university premises and not in secure facilities of law enforcement agencies, e.g., the PNP and NBI. WCPUs and hospitals currently face the same predicament of storage of SAKs in the absence of a policy that prescribes their automatic turnover to PNP or NBI.

The additional SAK components were not tested because of the high cost of molecular reagents needed for DNA testing. The government must address this issue by exploring options for tax exemptions and facilitating government procurements to increase the use of forensic DNA testing in routine criminal investigations. For the validation reported here, the detection of Y-DNA specific for males in the vaginal swab collected from a female child was considered sufficient to demonstrate that the process worked. However, the non-victim Y-DNA profile is only meaningful if compared to a suspect's reference Y-DNA profile. Hence a biological sample should have been obtained from the suspect or suspects following the Vallejo doctrine of the Philippine Supreme Court.<sup>19</sup> With the promulgation of the Rule on DNA Evidence in 2007,<sup>21</sup> several years after the validation study was conducted, the prosecution could now file a motion for DNA testing of the suspect's sample. Generally, the weight of the evidence depends on the rarity of the profile estimated from a reference database of the relevant population.<sup>22</sup> Y-DNA databases of the Philippine population are available for comparisons and calculations of likelihood ratios (LR) of matching DNA profiles.<sup>23-26</sup>

Notably, Y-DNA profiles are shared across paternally related persons, e.g., father and son or brothers. Only autosomal DNA profiles could completely individuate the male source of the Y-DNA detected in these samples. Unfortunately, without any court order and additional resources, the autosomal DNA tests were not conducted at the time. More recently, funding from the Philippine Council for Health Research and Development and ethics clearance from the UP Manila Research Ethics Board has allowed the NSRI-UPD DNA Analysis Laboratory to test 30 of these cases (19.5%) as part of a research program. These cases had been stored for more than 15 years, and positive DNA results would show if the conditions were sufficient for long-term storage. This new research initiative would help refine the proposed DNA workflow for routine sexual assault investigations in the Philippines and assess the suitability of the storage conditions. To date, autosomal DNA databases of the Philippine population have been made publicly available.<sup>27-30</sup> These databases are needed for calculating the likelihood ratio (L.R.) of the prosecution hypothesis (non-victim DNA observed is from the suspect) vs. the defense hypothesis (non-victim DNA observed is from another source, not the suspect).

Based on its records, the NSRI-UPD DNA Analysis Laboratory received only one subpoena to appear in court out of the 154 DNA test reports sent back to the WCPUs (0.65%). In this case, the prosecution used the Y-DNA test result to support the victim's testimony of sexual contact. After the testimony, the court did not order additional DNA tests to compare the Y-DNA profile generated from the child victim's vaginal swab against the suspect's reference DNA profile, nor the conduct of autosomal DNA testing to identify the actual source of the sample. The NSRI-UPD



DNA Analysis Laboratory does not know the case's outcome because the court did not provide the laboratory access to the case records or a copy of the final decision.

Because financing is a significant challenge in making DNA testing part of routine investigations, there is a need to determine cost-effective strategies to aid in identifying the best candidate sample/s from all the swabs and material contained in the SAK without compromising the integrity of the evidence. An integrated system for forensic DNA testing in the Philippines had been proposed,<sup>31</sup> which included provisions for preliminary screening using an alternative light source and an acid phosphatase test to identify locations of semen on a large piece of material, e.g., underwear or clothing. Confirmatory tests such as the semenogelin assay and microscopy can establish the presence of semen and sperm cells, respectively. Finally, DNA would be extracted from the remaining samples included in the SAK if the first tests using vaginal swabs did not yield positive DNA results.

DNA mixture analysis can be more difficult when 1) the proportion of female to male DNA is more than 10:1, 2) when handling incest rape cases because of the shared DNA amongst relatives, 3) having male victims and perpetrators, particularly those that are paternally related because they have the same Y-DNA profile and 4) when samples exhibit microbial growth due to prolonged or improper storage.<sup>31</sup> Methods to overcome these challenges continue to be developed. These methods include using conditional probability models,<sup>32,33</sup> the development of rapidly mutating Y-DNA markers that can differentiate paternally related males,<sup>23</sup> and massively parallel sequencing technology that can increase the likelihood of successful interpretation of DNA mixture profiles.<sup>23,32,34</sup>

### Limitations of the study

The study was limited to samples collected from child patients who consulted with the CPU within 72 hours of the last assault. More recent recommendations to collect from patients up to 120 hours from the previous incident remain untested.<sup>35</sup> For this study, only the internal vaginal swab, and oral reference swab were analyzed for DNA. The other samples remained untested in secure storage and are available for any future conduct of DNA tests. Male child patients should also be included in the validation to determine if the body swabs, e.g., anal, penile, and oral, collected from them, would also provide positive DNA test results. Also, only four units of the Child Protection Network participated, all of which are major team players located in regional urban centers with efficient courier services and relatively no transportation problems. Validation with contributions from more distant and geographically isolated WCPUs and health units is needed to evaluate further the evidence management system described here.

## CONCLUSION AND RECOMMENDATIONS

DNA technology is the most powerful forensic tool for human identification that could provide critical information in sexual assault investigations in the Philippines. Currently, the benefit of forensic DNA technology is not maximized in the country due to the inadequate resources and infrastructure allocated for the conduct of DNA tests. Without routine DNA tests in criminal investigations, court litigations will continue to rely heavily on verbal testimonies resulting in lengthy trials and delayed justice for victims. One step forward in getting more DNA tests done is to empower medical doctors with the tools such as a SAK. The kit will be used to systematically collect biological samples from patients who seek help within 72 hours and possibly 120 hours post-contact. Although SAKs are already produced and used overseas, a locally manufactured SAK will reduce the cost per kit. Reducing overall costs of sexual assault investigations is essential in countries like the Philippines, where resources are limited and the cost of forensic DNA testing is very high. Using a dedicated courier service to transport evidence was also successful, which considerably reduced the cost of funding persons to deliver evidence SAKs from source to laboratory personally. The transport of biological samples from Visayas and Mindanao to Camp Crame, where the first PNP DNA Laboratory is located, was partly addressed by the recent establishment of PNP DNA testing laboratories in Cebu City and Davao City.

It is recommended that all hospitals should be supplied with SAKs to ensure that these are readily available for medical doctors to use when a sexual assault victim consents to a medical examination and sample collection. Administrative policies or laws should direct law enforcement agencies to accept and store SAKs that other agencies had collected, e.g., WCPUs and government hospitals. Keeping these critical samples in secure physical facilities would give the patient, law enforcement agencies, and non-governmental agencies additional time to seek ways to have the DNA testing done if cost or chemical supply is an issue.

It is hoped that soon, more support for the routine uses of SAKs and DNA testing will be provided. The increased use of SAKs for collection and DNA testing during investigations would be a welcome development. It would result in the early identification and rehabilitation of victims and offenders, particularly important in cases involving children.

### Acknowledgment

The authors would like to acknowledge the assistance in collecting samples from the Child Protection Units of Baguio General Hospital Medical Center, Vicente Sotto Memorial Medical Center, Davao Medical Center, and the Child Protection Unit located at the University of the Philippines Manila - Philippine General Hospital. The authors are also grateful for the technical support provided

by the staff of the DNA Analysis Laboratory, NSRI-UPD, and Atty. Jose M. Jose for reviewing and editing the paper.

### Statement of Authorship

All authors participated in the data collection and analysis and approved the final version submitted.

### Author Disclosure

All authors declared no conflicts of interest.

### Funding Source

Office of the Vice-Chancellor for Research and Development and the Natural Sciences Research Institute, both located at the University of the Philippines, Diliman and the Development Innovation Marketplace with funding from the World Bank.

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