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Testing of the National Crime Information Center Missing/Unidentified Persons Computer Comparison Routine

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ABSTRACT: For many years the effectiveness of the National Crime Information Center (NCIC) missing and unidentified persons matching program has been in question. The reliability of the NCIC matching system was tested using actual cases. When entered with the original information as provided by the investigating agencies, none of the four test cases were successfully matched. The NCIC system is the only source that links the states with this type of information. The use of NCIC for the entry of missing and unidentified persons information is still recommended, however, entered information should be reviewed by a qualified individual to insure accurate data entry. For accurate matching of information a proven parallel system should be used by every state.

KEYWORDS: odontology, NCIC, computer, dental comparison, dental characteristics, missing persons, unidentified persons, CAPMI, physical anthropology

The National Crime Information Center (NCIC) Missing and Unidentified Person Program was established to provide assistance in the identification of unidentified deceased individuals as mandated by Congress in the Missing Children Act of 1982 [1]. The House and Senate Conference Committee recommended that the FBI establish the program with the aid of an advisory group of experts in the field of identification. To this end an eight member advisory panel called the NCIC Unidentified Person Task Force was formed. It included three members with backgrounds in either dentistry or dental identification. The task force recommended that the system should be basically designed to assist in four areas. The first and primary function was to aid in the identification of unidentified deceased individuals [2]. In addition, it was recommended that the system also should aid in the identification of unknown living individuals; provide a means to link multiple agencies that have recovered parts of one body; and provide assistance in the identification of victims of a catastrophe. The test procedures and results described in this article will deal with the primary function of the identification of unknown deceased individuals.

In 1982, awareness of the importance of collecting missing and unidentified persons information in Washington State had been prompted by the discovery of multiple bodies in and around the Seattle area, which eventually led to the Green River serial killer investigations. One primary problem surfaced early on in the investigation and that was

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the identification of the victims [3,4]. The condition of the bodies, many of which were either badly decomposed or skeletonized, often precluded the use of fingerprints for their identification, thus, dental information held a key role in the process of identifying the victims.

Washington State legislative action created the Washington State Patrol Missing/Unidentified Persons Unit (M/UPU) in November, 1984. Along with the formation of the Unit, the legislators enacted two laws² that required the investigating agencies to submit dental records to M/UPU of people that have been missing in excess of 30 days and dental records of unidentified remains that the coroner/medical examiner have not been able to identify.

From the time of its formation, the Unit has encouraged law enforcement and coroner/medical examiner agencies to submit dental information on their missing and unidentified persons. Compared to the national statistics of missing persons dental submissions the Unit is third in the nation with 148 missing persons with dental information. The two states that have more submissions are California with 226, and New York with 213. The only other states close in numbers to these submissions are Florida with 133 and Michigan with 98. All the rest of the states have less than 55 with 28 states having less than 10. As of January 13, 1992, there were 73 243 missing persons entered in NCIC and only 1362 had dental information. This is less than 2% of submissions. Washington has an 8% submission rate, New York has 5%, Michigan has 3%, Florida has 2% and California has a 1% rate. It is obvious that 100% submission is not attainable because many of the missing persons may not have dental records available, however, submission rates in all states could be much improved.³

Washington ranked seventh in the nation for unidentified persons dental submissions with 41. It was preceded by California (441), Florida (131), New Jersey (72), New York (58), Nevada (56), and Illinois (46). As of January 13, 1992, there were 2199 unidentified bodies entered in NCIC. Unidentified remains with dental information entered in NCIC is listed as 1161, which calculates to a 53% submission rate. Washington has an 82% submission rate, Nevada has 77%, California has 57%, Florida has 57%, New Jersey has 55%, Illinois has 54%, and New York has 43%. Complete submission of dental information is not possible because of the lack of oral structures in some recovered remains.

The main service provided by the WSP M/UPU was the ease at which agencies could retrieve submitted records for confirmation of the identity of a deceased individual that had a presumptive identification. In many cases the Unit was also responsible for the identification of remains from the analysis of fingerprints with the aid of the automated fingerprint identification system (AFIS). In 1990, M/UPU began a total review of all missing and unidentified persons dental information submitted to the Unit. This information along with the physical descriptors was then entered into a computer comparison program called computer aided postmortem identification (CAPMI), which was developed and distributed by the United States Army [5,6]. Upon completion of this project, CAPMI was used successfully to aid in the identification process of numerous unidentified persons in Washington State.

Questioning of state officials involved in missing and unidentified persons investigations revealed that, to their knowledge, the dental on line search routine of NCIC has never been responsible for producing candidates that have eventually resulted in a positive identification in the state of Washington. In fact, there had been rumors from the Green River investigation that at least one of the victims had been in the NCIC system for some time and had never been matched up with the remains even though there was a perfect

²Washington State RCW 68.50.310 and RCW 68.50.320.

³"NCIC in the Autopsy Room," *National Crime Information Center—A Newsletter for the Criminal Justice Community*, Vol. 24, No. 2, August, 1991.

dental match. Concerns for the lack of results led to contact with officials at the National Crime Information Center.⁴

The concerns expressed to NCIC could be grouped into four categories. The first concern is the dental NCIC form for missing and unidentified persons. Its complexity and the subjective nature of the information that can be entered in some of the fields can lead to errors or omissions in interpretation, entry and comparison results. It was recommended that the form be simplified and only objective entries be made. In 1983 the King County Dental Society formed a dental team that would respond in the case of a mass disaster. At that time, the NCIC program was announced to be capable of comparisons in such a situation. Several dentists were trained in the proper protocol for completing the NCIC form. Following the training, the dentists were given actual maxillas and mandibles for their examination and coding on the NCIC forms. For identical dental specimens, there were no two forms that had the same information. NCIC's response was that because the system deals with an open population with thousands of records, any system less comprehensive would not work. The NCIC task force did recommend that both the missing person and unidentified person data collection guides be contracted out to a professional layout/design company for improvement.

The second category dealt with the quality of the existing information that was in NCIC. It is not uncommon to see impossible dental attributes entered in the dental characteristics portion of an NCIC print out. Such entries as "missing-healed" teeth with restorations have been observed on lists of possible candidates. These errors are either entry errors from the key board or mistakes made when filling out the form. Quality control needs to be established to either eliminate or correct misinformation that is being entered into the NCIC system. The Washington State Patrol established a quality control measure that allows the agencies taking the missing or unidentified persons report to enter the physical descriptors but they can not enter the dental information. This dental information is reviewed, coded, and entered by the staff at the Washington State M/UPU thus assuring that the information is entered correctly by experienced forensic dentists and data-entry personnel.

A third area of concern with the NCIC program was the impression that this program would function in a mass disaster situation. This caused many agencies to believe that there was no need for any other system to handle multiple-casualty incidents because they have been told that NCIC can fulfill the need for computer assistance in the identification process. There are other proven comparison programs available for this type of incident that are much more efficient and portable. NCIC's response to this concern was "Assistance for the identification of catastrophe victims was an 'add on' objective, but the Task Force felt that the System should be available for this humanitarian purpose if no other dedicated system was available or practicable."⁵

The fourth category of concern dealt with the weighting or scoring of the dental information in the NCIC search routine. Possible matching candidates are listed only if the comparison process achieves a certain threshold score. Those items that are scored are sex, race, year of birth, estimated date of death, date body found, height, weight, eye color, hair color, blood type, scars, marks, tattoos, jewelry type, proximity of missing persons last contact to body recovery site, and dental characteristics. Many times recovered remains are skeletonized, burned, fragmented, or badly decomposed. Physical descriptors such as age, stature, and date of death are available only as estimated ranges. In these situations, of all the identifying characteristics, the dentition is the most reliable and impervious to deterioration and should be weighted accordingly. A perfect or near

⁴Personal correspondence dated July 6, 1990 to Mr. Robert D. Moran, Forensic Science Training Unit, FBI Academy.

⁵Answer to personal correspondence dated September 25, 1990, from Mr. David F. Nemecek, Chief, National Crime Information Center.

perfect dental match should achieve the minimum threshold score in itself despite either the lack of physical descriptors or exact match information in these fields. NCIC's response to this concern was that a study has been initiated that will look into the possibility of eliminating or reducing the required threshold score for physical descriptors in situations when dental characteristics are the primary or only descriptors available in an unidentified person record. NCIC also granted permission for real-time tests to document problems with the record matching software.

Cases Tested and Results

The testing began in March of 1991 and consisted of the entry of information from four actual cases that had been successfully identified through the aid of CAPMI. The Washington State Patrol is using this as a parallel system to ensure that the comparison of the missing and unidentified persons information is being accurately searched. CAPMI uses a search routine that ranks all records in a file as to the number of dental matches, possible matches and mismatches. All dental records received by the Washington State Patrol are entered in NCIC and CAPMI.

The first case used for testing the NCIC system involved physical and dental data from an incident involving the discovery of dismembered remains of a white female found approximately 110 miles east of Seattle, Washington. The information listed under "Unidentified" in Table 1 was entered into NCIC. A missing persons report was taken by an agency in the Seattle area and the physical descriptors and dental information listed under "Missing" in Tables 1 and 2 were entered into Washington crime information center (WACIC), which automatically forwards to NCIC. WACIC uses the same algorithms for its search routine as does NCIC except that the threshold score for candidates has been reduced. Three search routines were launched and yielded no matching records. A comparison routine launched in CAPMI registered the correct missing person as the first candidate of possible matches to the unidentified remains. This was using a data base of approximately 450 missing persons with dental information. An examination of the ante- and postmortem radiographs confirmed the identification. An analysis of the available printouts from WACIC and NCIC was accomplished to ascertain why NCIC and WACIC were not generating the correct missing person on its list of possible candidates.

One problem was discovered in that the dental information was never entered for the unidentified remains. All searches had been on physical descriptors only. This brought up another problem. Why did it not hit on the physical descriptors entered? Since there were two fields, namely height and weight that did not match, it was thought that this was the reason that NCIC did not generate the actual match in its list of possible matches.

TABLE 1—Case #1, physical descriptors entered in NCIC from information received on unidentified examination and missing person report of same individual. Note that height and weight discrepancies are not uncommon.

Person Status	Missing	Unidentified
Sex (SEX)	Female	Female
Race (RAC)	White	White
Height (HGT)	66"	64" to 65"
Weight (WGT)	140 lbs	120 lbs to 125 lbs
Eye Color (EYE)	Blue	unknown
Hair Color (HAI)	Brown	Brown
YOB/EYB	1967	1960 to 1970
Blood Type (BLT)	unknown	unknown
SMT	none	none
DLC/DBF	11/16/89	3/14/90

TABLE 2—Case #1, dental information entered in NCIC from information received on unidentified examination and missing person report of same individual. The only mismatch is on Tooth #15 all other entries are either exact matches or possible matches.

Tooth #	Missing	Unident.	Tooth #	Missing	Unident.
1	Virgin	Virgin	32	Virgin	Virgin
2	Occl 1	Occl 1	31	Occl 1	Occl 1
3	MO 1	MO 1	30	Occl 1	OF 1
4	MOD 1	MOD 1	29	Virgin	Virgin
5	DO 1	DO 1	28	Virgin	Virgin
6	Virgin	Virgin	27	Virgin	Virgin
7	Virgin	Virgin	26	Virgin	Virgin
8	Virgin	Virgin	25	Virgin	Virgin
9	Virgin	Virgin	24	Virgin	Virgin
10	Virgin	Virgin	23	Virgin	Virgin
11	Virgin	Virgin	22	Virgin	Virgin
12	DO 1	DO 1	21	Virgin	Virgin
13	DO 1	DO 1	20	Virgin	Virgin
14	MO 1	MOL 1	19	DO 1	DOF 1
15	DO 1	OFL 1	18	Occl 1	OF 1
16	Virgin	Virgin	17	Virgin	F1

The missing person was listed at one inch over the height range of the unidentified and the weight was fifteen pounds above the range entered for the unidentified person.

The dental information, which is listed under "Unident" in Table 2, was entered for the unidentified person. This generated a NCIC search that failed to list the actual match in the first one hundred possible candidates. The physical descriptors of these one hundred possible candidates were studied and the results are presented in Table 3. The searches were 100% reliable for Sex and Date of Last Contact being earlier than the Date the Body was Found. Race was the next most reliable followed by hair color. Height and Weight were not that reliable and the least reliable was the Year Of Birth (missing person) compared to the Estimated Year of Birth (unidentified remains).

The second candidate on the NCIC list was a white female with a year of birth of 1973. She was 5'2" (157.5 cm), 112 pounds (50.9 kg) with blonde hair. The only physical descriptors that matched the unidentified record were sex and race. The NCIC print out listed the "Match Data" as "DCH" (dental characteristics). Comparing the dental characteristics of this missing to the unidentified yielded a result of ten exact matches, ten possible matches (conditions that could have changed if the individual had treatment performed after the date of the dental records that were reviewed) and twelve mismatches (changes that are not possible except for a mistake in charting) [5]. Since the known match has 26 exact matches, five possible matches and one mismatch (a mistake in charting), it was again puzzling as to why it was not on the list of NCIC possible candidates.

TABLE 3—Case #1, percentages indicate the number of possible matches that either fell within the unidentified range or exactly matched the unidentified field.

NCIC Fields	Unidentified	% Match
SEX	Female	100%
RAC	White	93%
HGT	64" to 65"	53%
WGT	120 lbs to 125 lbs	50%
HAI	Brown	74%
YOB/EYB	1960 to 1970	41%
DLC/DBF	3/14/90	100% (DLC < DBF)

The unidentified and known missing person records were cleared from NCIC and WACIC. They were then re-entered with the same physical descriptors as shown in Table 1. The dental information was entered correcting the mismatch and making the possible matches exact matches. The search that was generated by doing this was successful. The "Match Data" for the unidentified and missing person matching candidate was "DCH" (dental characteristics). A logical explanation for this result was not readily apparent considering the previous search results and the listing of candidates with more mismatches than the actual match.

The second case tested involved the records of partially decomposed remains of a white female found in a wooded area about 45 miles from Seattle. The physical descriptors of the unidentified remains and the corresponding missing person are listed in Table 4. The dental information that was entered is listed in Table 5. It was noted that there are sixteen exact dental matches, twelve possible matches and four mismatches. The number of dental mismatches is still well within the parameters of other dental characteristic hits that NCIC has produced. The NCIC comparison results for both the missing and uni-

TABLE 4—Case #2, physical descriptors entered in NCIC from information received on unidentified examination and missing person report of same individual. All entries are either exact matches or possible matches.

Person Status	Missing	Unidentified
SEX	Female	Female
RAC	White	White
HGT	60"	60" to 64"
WGT	110 lbs	unknown
EYE	Blue	unknown
HAI	Brown	Brown
YOB/EYB	1954	unknown
BLT	unknown	unknown
SMT	none	none
DLC/DBF	05/11/91	08/05/91

TABLE 5—Case #2, dental information entered in NCIC from information received on unidentified examination and missing person report of same individual. Entries on Teeth #'s 2, 9, 15 and 24 are mismatches. Entries on Teeth #'s 1, 5, 7, 8, 13, 16, 17, 21, 22, 26, 28, and 29 are possible matches. All the other teeth are exact matches.

Tooth #	Missing	Unident.	Tooth #	Missing	Unident.
1	Occl 1	Missing	32	Missing	Missing
2	Missing	PM Missing	31	SSC	SSC
3	MOL 1	MOL 1	30	MODFL 1	MODFL 1
4	MOD 1	MOD 1	29	MOD 1	PM Missing
5	DO 1	PM Missing	28	MOD 1	PM Missing
6	Virgin	Virgin	27	Virgin	Virgin
7	L 1	M 3, L 1	26	Virgin	PM Missing
8	M 3	MI 3	25	Virgin	Virgin
9	M 3, L 1	D 3, L 1	24	M 3	D 3
10	L 1	L 1	23	Virgin	Virgin
11	L 1	L 1	22	Virgin	M 3
12	DO 1	DO 1	21	DO 1	PM Missing
13	MOD 1	PM Missing	20	MOD 1	MOD 1
14	OL 1	OL 1	19	Missing	Missing
15	DOFL 1	MOL 1	18	Occl 1	Occl 1
16	No Info	Missing	17	No Info	No Info

identified records yielded the same response, “*the search did not produce any possible matches.*” The unidentified record was then modified to exactly match the dental information of the missing person. The resultant NCIC search yielded no possible matches. The height range on the missing persons record was modified to generate another search of the missing record to the NCIC data base of unidentified persons. The result was that no matching records were found.

The third case used to test the NCIC system involved the skeletonized remains of a 12-year-old white girl. The remains had been exposed to the elements for approximately six years and many skeletal parts were not recovered. Physical descriptors were minimal (Table 6) but there was adequate dental information to provide an identification (Table 7). The maxilla was intact although when it was recovered several teeth had fallen out post mortem. A further search of the area produced all of the missing maxillary teeth and a few mandibular teeth. The mandible itself was never recovered. This child was undergoing fixed orthodontic treatment at the time of her death so there were some unusual dental characteristics for use in a search. Analysis of this dental data indicates

TABLE 6—Case #3, physical descriptors entered in NCIC from information received on unidentified examination and missing person report of same individual. No mismatches on entries.

Person Status	Missing	Unidentified
SEX	Female	Female
RAC	White	unknown
HGT	65"	unknown
WGT	110 lbs	unknown
EYE	Hazel	unknown
HAI	Brown	unknown
YOB/EYB	1973	unknown
BLT	unknown	unknown
SMT	none	none
DLC/DBF	9/19/85	08/04/91

TABLE 7—Case #3, dental information entered in NCIC from information received on unidentified examination and missing person report of same individual. No mismatches entered. Mandible was not recovered but teeth #'s 20, 25, 26, 27, and 29 were recovered along with the maxilla and all of the maxillary teeth present at the time of death.

Tooth #	Missing	Unident.	Tooth #	Missing	Unident.
1	Impacted	Impacted	32	Impacted	No Info
2	Virgin	Occl. Sealants	31	Virgin	No Info
3	OL 1, Banded	OL 1, Banded	30	O 1, Banded	No Info
4	Banded	Banded	29	Banded	Virgin
5	Missing	Missing	28	Missing	No Info
6	Bracket	Bracket	27	Bracket	Virgin
7	Bracket	Bracket	26	Bracket	Virgin
8	Bracket	Bracket	25	Bracket	Virgin
9	Bracket	Bracket	24	Bracket	No Info
10	Bracket	Bracket	23	Bracket	No Info
11	Bracket	Bracket	22	Bracket	No Info
12	Missing	Missing	21	Missing	No Info
13	Banded	Banded	20	Banded	Virgin
14	OL 1, Banded	OL 1, Banded	19	OF 1, Banded	No Info
15	Virgin	Occl. Sealants	18	Virgin	No Info
16	Impacted	Impacted	17	Impacted	No Info

14 exact matches, 18 possible matches, and no mismatches. The NCIC comparison results for both the missing and unidentified records yielded the same response, "the search did not produce any possible matches."

The fourth case used for testing the NCIC search system involved information surrounding the discovery of a human cranium near a river in Pierce County, Washington. A thorough search of the area recovered no other remains. It was thought that the cranium had been washed downstream from the original dump site of the body. During this process, all teeth in the maxillary arch were lost except for one retained deciduous tooth. Physical and dental descriptors (Tables 8 and 9) were understandably minimal. An anthropological examination revealed that the cranium was that of a female and probably caucasoid. The dental examination yielded information that determined what teeth were present at the time of death but no restoration information was available except for the one retained deciduous tooth ("J"), which had no restorations. Analysis of the dental comparison of the available information yielded three exact matches, 29 possible matches and no mismatches. The NCIC search of the unidentified information on the missing persons file yielded no possible matches. The missing persons search of

TABLE 8—Case #4, physical descriptors entered in NCIC from information received on unidentified examination and missing person report of same individual. The cranium was the only remains recovered thus limiting the amount of physical descriptors for entry.

Person Status	Missing	Unidentified
SEX	Female	Female
RAC	White	unknown
HGT	62"	unknown
WGT	120 lbs	unknown
EYE	Green	unknown
HAI	Blonde	unknown
YOB/EYB	1963	unknown
BLT	unknown	unknown
SMT	none	unknown
DLC/DBF	08/12/89	07/20/91

TABLE 9—Case #4, dental information entered in NCIC from information received on unidentified examination and missing person report of same individual. Teeth #s 1, 13 and 16 are exact matches all the rest are possible matches.

Tooth #	Missing	Unident.	Tooth #	Missing	Unident.
1	Missing	Missing	32	Missing	No Info
2	Virgin	PM Missing	31	Missing	No Info
3	O 1	PM Missing	30	O 1	No Info
4	Virgin	PM Missing	29	Deciduous	No Info
5	Virgin	PM Missing	28	Virgin	No Info
6	Virgin	PM Missing	27	Virgin	No Info
7	Virgin	PM Missing	26	Virgin	No Info
8	Virgin	PM Missing	25	Deciduous	No Info
9	Virgin	PM Missing	24	Deciduous	No Info
10	Virgin	PM Missing	23	Virgin	No Info
11	Virgin	PM Missing	22	Virgin	No Info
12	Virgin	PM Missing	21	Virgin	No Info
13	Deciduous	Deciduous	20	Deciduous	No Info
14	O 1	PM Missing	19	O 1	No Info
15	Virgin	PM Missing	18	Missing	No Info
16	Missing	Missing	17	Missing	No Info

the NCIC unidentified persons file yielded five possible matches, which did not include the actual match.

The first possible match candidate on the NCIC list for Case #4 was an unidentified white female recovered in Arkansas. A major error in the comparison was that the body in Arkansas was found four years prior to the date of last contact for the missing person. The NCIC matching data was listed as dental characteristics. The analysis of the dental information showed four exact matches, 23 possible matches and five mismatches.

The second candidate on the list of possible candidates generated by NCIC for Case #4 was the remains of a white female with an estimated year of birth between 1954 and 1969 and was recovered in Riverside County, California. The unidentified's physical descriptors were entered as two inches taller and five pounds lighter than those of the test missing person. The unidentified also had brown hair instead of blonde hair. The matching data was entered as all fields. There was no dental information available from the unidentified remains.

The other NCIC possible match candidates were reviewed and found to have similar inconsistencies. The only explanation that could be derived for the reason that the test unidentified record was not listed in the possible match candidates was that there was not enough information listed to achieve a score that would indicate that it was a possible match.

Conclusions

None of the four cases tested would have been successfully matched by the NCIC system if entered with the information as provided by the agencies that were investigating the missing and unidentified persons reports. Although one case was successfully matched it was accomplished by modifying the original entries with information and procedures that would not normally be available or accomplished in a real case scenario. An attempt to duplicate this successful NCIC search with information from Case #2 was not successful.

Not only does the dental comparison routine seem to be inconsistent in its search results but it appears that the physical descriptors comparison routine is also inconsistent. Because the cases tested are not uncommon situations in Washington State and certainly not that unusual in other areas of the United States, total reliance on NCIC's normal search routine to generate accurate matches between missing and unidentified remains is not recommended.

Recommendations

NCIC is the only system available that links investigating agencies in the Nation and continued use of the system is strongly recommended. It does provide a national central repository for missing and unidentified persons information that can be accessed either by direct inquiry or off line search routines. Despite the apparent on line search routine issue, the larger problem that this paper briefly touches on is the submission of dental records of missing and unidentified persons. It does not matter whether the search routine functions well if the records for comparison are not submitted. Law-enforcement agencies, coroners, and medical examiners should be making every effort to collect all information necessary for the identification of an individual.

Each individual state should form a central repository for missing and unidentified persons information for their investigating agencies. This information should be reviewed by qualified experts and entered into NCIC *and* a proven comparison system for assurance that accurate candidate lists will be generated. Regional interstate exchange of missing/unidentified persons information is also highly recommended.

In the unlikely event that the tests performed by the Washington State Patrol have identified a problem that is unique to Washington State, other states are encouraged to perform their own tests using actual information on known matches. NCIC should be notified of the results so the missing and unidentified persons search routine can be improved to satisfy the expectations of the agencies that rely on it to aid in their investigations.

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