Cheri Lewis,[1] *DDS*

WinID2 versus CAPMI4: Two Computer-Assisted Dental Identification Systems

REFERENCE: Lewis C. Win ID2 versus CAPMI4: two computer-assisted dental identification systems. J Forensic Sci 2002; 47(3):536–538.

ABSTRACT: Disasters produce victims that require identification. Comparing antemortem and postmortem dental records provides an important means of identification. Computers have assisted this process. Currently, the principal computer programs are CAPMI4 and WinID2. The present study compared these programs on a sample of 100 simulated victims and 105 simulated postmortem fragments. CAPMI4 provided 48 correct matches and WinID2 provided 71 correct matches. In addition, comparisons were made within WinID2 to determine which of its three dental data sets was the most successful for suggesting correct matches.

KEYWORDS: forensic science, forensic odontologist, victim identification, computers, computer-aided dental identification, dental restorations

When mass disasters occur, victims require identification. The forensic odontologist is an integral member of any identification team. The smaller the number of victims to be identified, the more intact the remains, the more complete the antemortem and postmortem records, the easier will be the task (1,2,3). Computer-aided dental identification has existed in the literature for 27 years (4). Researchers have investigated the efficacy of these computer programs in real and simulated disasters. Prior to the introduction of computers, training programs consisted simply of providing for the placement of a single postmortem case at a single workstation and walking the tables with antemortem records (5). This process took considerable time and space. Training for the forensic odontologist now involves simulation crashes with and without computers. The ideal computer program should provide the forensic odontologist with an efficient means of comparing antemortem records and postmortem records in order to produce accurate matches. Unfortunately, present computer programs are less than ideal and the forensic odontologist must certify matches suggested by a program (2). When making a match, the forensic odontologist utilizes identifying factors such as pulp morphology, crown and root anatomy, size of restorations, the use of bases under restorations, and trabeculation patterns. The odontologist analyzes these factors in ways that are difficult to encode into a computer program. The most utilized computer programs at present are WinID2 (6) and CAPMI4. At this writing, the latest version of WinID is WinID2, version 2.3.7. The purpose of this investigation was to compare WinID2 and CAPMI 4 with respect to accuracy and efficiency, with particular attention paid to the three data sets provided by WinID2.

The first computer program to gain wide distribution was CAPMI (Computer-Assisted Postmortem Identification system). It first appeared in the literature in 1986 (1). Developed at the U.S. Army Institute of Dental Research, this DOS-based system rapidly became the standard computer program used throughout the world (3,8). CAPMI4 is currently distributed through Dr. Gary Bell, Forensic Dental Advisor for the Washington State Patrol. The source code of the computer program is not available and therefore modifications are not possible (6).

Despite the common use of CAPMI4, the United States Public Health Service DMORT (Disaster Mortuary Operational Response Team) standardized on WinID in 1996 (6). WinID2 (Windows Identification) is a Windows-based system designed and distributed by Dr. James McGivney, Assistant Professor, Center for Advanced Education, St. Louis University, Missouri. The WinID program was initially released as an upgraded version of CAPMI4; it has the ability to convert data from CAMPI4 to WinID. Since then, codes have been added to meet current needs of restorative dentistry. WinID2 presents four data sets, which are called "Most Dental Hits," " Least Dental Mis-matches," "Most Dental Hits Less X = X and V = V," and "Most Identifier Matches." Each data set provides its own correct matches. "Most Identifier Matches" requires non-dental data and has not been considered in this study. "Most Dental Hits" suggests matches by finding similarities between antemortem records and teeth retrieved from the disaster scene. "Least Dental Mis-matches" suggests matches by finding dissimilarities, with zero dissimilarities ("0 misses") being optimal. "Most Dental Hits Less X = X and V = V" suggests matches based solely on dental restorations. This data set eliminates "all hits generated when a virgin tooth is matched to a virgin tooth and when an extracted tooth is matched to an extracted tooth" (personal communication with Dr. James McGivney, June 2001). Particular attention will be paid to "Least Dental Mis-matches" since McGivney has argued that this set is especially useful where fragmentation of postmortem records occurs (6).

The present study compared CAPMI4 and WinID2 on a sample of 100 simulated victims and 105 simulated postmortem fragments. In addition, comparisons were made within WinID2 to determine which of its three dental data sets was the most successful for suggesting matches.

Method

The dental records of 100 individuals provided the basic data for this study. These records provided for the creation of 100 simulated antemortem records, each with a fictitious name, and 105 simulated

[1] 8500 Wilshire Blvd., Suite 805, Beverly Hills, CA 90211.

Received 3 July 2001; and in revised form 13 Sept. 2001; accepted 15 Oct. 2001.

postmortem fragments, each with a randomly assigned medical examiner number. The antemortem records contained the following dental characteristics: no dental restorations, single surface dental restorations, multiple surface dental restorations, single crowns, bridges, and individuals with removable dental prostheses. The antemortem radiographs contained 67 full mouth sets, 23 sets of bitewings, and 10 partial sets. The dental radiographs were computer scanned and retained for archival use. (Researchers should contact the author for access to the archive.)

The postmortem records were created by selecting radiographs from the collection of radiographs available for each individual. The intent was to simulate radiographs of dental fragments of individuals from an airplane crash. These radiographs were computer scanned and retained for archival use.

The most recent restorative patterns for each individual found in the antemortem dental and radiographic records were written up using WinID2 and CAPMI4 codes. WinID2 and CAPMI4 programs were loaded in a computer. All computer codes were entered into their respective programs. Programs were activated to suggest matches between antemortem and postmortem records in order to identify the 100 individuals in this study. Each program provides for matches in a descending order with the most likely match at the top of the list and the least likely at the bottom. For this study, a program was considered to have provided a correct match if one of the program's top three choices was correct.

Results

There were 100 simulated victims with 105 fragments. Table 1 presents the basic data from the study. It shows correct matches for CAPMI4 and WinID2 for the 105 fragments. The first column identifies the number (shown in parentheses) and kind of simulated postmortem "Fragments" utilized in this study. The next three columns represent the three dental data sets for WinID2, with the numbers indicating correct matches. The next column, "WinID2 All Data Sets," combines the results from the previous three columns. The numbers, however, do not add up to the combined number because a fragment could be correctly identified by more than one data set but only one correct identification is credited to the "WinID2 All Data Sets" column. The numbers in the "CAPMI4" column indicate the number of correct matches made by CAPMI4.

There were 17 fragments with virgin teeth (teeth without any dental restorations), 43 fragments with filled teeth, 32 fragments with teeth having crowns and/or bridges, 11 fragments with edentulous areas requiring removable prosthetics for esthetics and/or function, and two fragments with root(s) present and no clinical crowns. The overall totals show that CAPMI4 provided 48 correct matches and WinID2 provided 71 correct matches.

Looking specifically at the several kinds of fragments, CAPMI4 did better than the WinID2 data sets on matching the 17 fragments with virgin teeth. The WinID2 dental data sets did better than CAPMI4 on 75 fragments with filled teeth and crowns and bridges; WinID2's "Most Dental Hits Less X = X and V = V" performed best on the identification of these restorative patterns. CAPMI4 and WinID2 performed equally on the 11 fragments with edentulous areas requiring removable prosthetics. WinID2's "Most Dental Hits Less X = X and V = V" provided the only match for the two fragments with only root(s) present.

McGivney has argued for the importance of the "Least Dental Mis-matches" data set. Comparison of the three data sets shows that, overall, "Least Dental Mis-matches" identified 40 matches but that "Most Dental Hits" identified 44 matches and "Most Dental Hits Less X = X and V = V" identified 50 matches. Contrary to McGivney's position, "Least Dental Mis-matches" did worse than the other two data sets overall. Nevertheless, it did provide five correct matches within its top three choices that were not found in the top three choices of the other two data sets (not shown in the table).

For the 86 postmortem records with dental restorations (filled teeth, crowns/bridges, removable prosthesis), "Most Dental Hits Less X = X and V = V" provided 48 matches within its top three choices while "Most Dental Hits" provided 40 matches and "Least Dental Mis-matches" provided 35 matches. "Most Dental Hits" and "Least Dental Mis-matches" had many correct matches in common. Taken together, these two data sets produced a total of only 44 correct matches—a worse performance than that achieved by "Most Dental Hits Less X = X and V = V" by itself.

Discussion

The present study was the first to compare CAPMI and WinID in any of their versions—and the results strongly favor WinID. Since CAPMI4 and WinID2 utilize different comparison algorithms, performance differences were expected (6). The results showed that WinID2 provided 71 correct matches and CAPMI4 provided 48. This is a large difference and suggests that WinID2 will provide faster victim identifications in the field than will CAPMI4.

Both programs had limited value for the 17 fragments having no dental restorations. This was expected since restorative patterns provided most of the data entered for victim identification (9). Nevertheless, CAPMI4 performed better than WinID2 for these fragments. The results for fragments with no dental restorations support Lorton's statement that "there is a threshold amount of data, below which sorting by simplified criteria may become nonproductive"(3).

TABLE 1—*Summary of CAPMI4 and WinID2 results.*

	Win ID2				
Fragments	Most Dental Hits	Least Dental Mismatches	Most Dental Hits X=X V=V	All Dental Data Sets	CAPMI4
Virgin Teeth (17)	4	5	1	6	8
Filled Teeth (43)	16	14	22	30	15
Crowns/Bridges (32)	16	14	21	25	16
Removable Prosthesis (11)	8	7	5	9	9
Root(s) Only (2)	0	0	1	1	0
Totals (105)	44	40	50	71	48

WinID2's "Most Dental Hits" data set was designed to mimic CAPMI4—and it did when dental restorations were present. Both programs performed almost identically for the 86 fragments with dental restorations: each program provided 40 matches. However, for the 17 victims without dental restorations, CAPMI4 provided eight matches while "Most Dental Hits" provided four matches, making CAPMI4 the program of choice when no dental restorations are present. Neither the "Most Dental Hits" data set nor CAMPI4 provided matches for the two fragments with root(s) only.

WinID2's "Least Dental Mis-matches" was designed for use where fragmentation of postmortem records was present, as was the case in this study. Despite this, this data set provided the fewest matches for the 86 fragments with dental restorations. Only five victims were identified exclusively by this data set—less than 5% of the total identifications. This data set does little to improve the results obtained by using the "Most Dental Hits" data set alone. Overall, WinID2's "Least Dental Mis-matches" provided only 40 matches while CAPMI4 provided 48 matches.

WinID2's "Most Dental Hits Less X = X and V = V," which produces matches based entirely on dental restorations, was the most successful data set overall when dental restorations were present. This supports Lorton's statement that "the greatest number of restored tooth surfaces in antemortem records tend to be easiest to identify and most likely to be prioritized at the top of a sort" (3). For the 86 fragments with dental restorations, this data set provided 48 matches compared with the 44 matches provided by the other two WinID2 data sets combined (again giving common matches one credit), making this the preferred data set when dental restorations are present. For the 86 fragments with dental restorations, CAPMI4 provided only 40 matches. "Most Dental Hits Less X = X and V = V" provided the only identification when root(s) only were present.

WinID2 is a work in progress (personal communication with Dr. James McGivney, June 2001) and modifications may improve its performance for fragments with zero restorations. "Least Dental Mis-matches" should be improved, eliminated, or perhaps combined with another dental data set. Modifications to WinID should be assessed with empirical research.

This study should be interpreted with caution. Real life disasters can provide different restorative patterns than the ones used here (8). For example, if victims came from fluoridated areas, their dental restorations would be minimal. Here, CAPMI4 may perform better overall than WinID2.

Acknowledgments

The author wishes to acknowledge Dr. Les Leventhal for his editorial support.

References

1. Lorton L, Langley WH. Design and use of a computer-assisted portmortem identification system. J Forensic Sci 1986;31(3):972–81.
2. Lorton L, Rethman M, Friedman R. The computer-assisted postmortem identification (CAPMI) system: a computer-based identification program. J Forensic Sci 1988;33(4):977–84.
3. Lorton L, Rethman M, Friedman R. The computer-assisted postmortem identification (CAPMI) system: sorting algorithm improvements. J Forensic Sci 1989;34(4):996–1002.
4. Kogon SL, Petersen KB, Locke JW, Petersen NO, Ball RG. A computerized aid to dental identification in mass disasters. Forensic Sci 1974 3:151–62.
5. Armed Forces Institute of Pathology, 25th Annual Course in Forensic Dentistry. 1989.
6. McGivney J, Fixott RH. Computer-assisted dental identification. Dental Clinics of North America 2001;45(2):309–25.
7. Williams AB, Friedman RB, Lorton L. A new algorithm for use in computer identification. J Forensic Sci 1989;34(3):682–6.
8. Friedman RB, Cornwell KA, Lorton L. Dental charteristics of a large military population useful for identification. J Forensic Sci 1989;34(6): 1357–64.

Additional information and reprint requests:
Cheri Lewis, DDS
8500 Wilshire Boulevard, Suite 805
Beverly Hills, California 90211
Phone: (310) 659–5480