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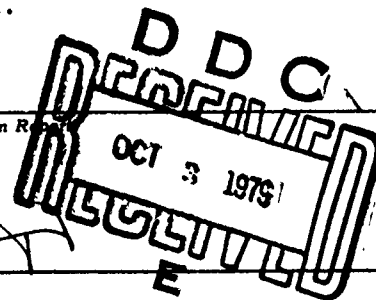
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The extent of agreement in soldier death count between two independent electronic information systems in the United States Army, one medically-based and the other personnel-based, was studied for calendar years 1975 and 1976 and was found to be unsatisfactory for epidemiologic purposes. The two death lists shared only 63.5 percent commonality in the total mortality count of 2458 cases. Agreement in suicide labeling was also studied and found to be even lower. Possible reasons for the discrepancies are discussed, and implications of such low reliability

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for military epidemiology are drawn. It is unknown whether the low reliability found in the military setting is also a significant problem in the United States in general, but it was learned that death enumeration is not a new problem to the English-speaking world.

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# The Reliability of Mortality Count and Suicide Count in the United States Army

William E. Dattel, Ph.D.\*

"Our Parocial Registers are in many instances now kept by Parish-Clerks, and as these Record-keepers derive no profit from the employment, except a casual shilling now and then for a search, it may be imagined what sort of Record is kept, where ignorance and negligence are united."

A correspondent of *The Gentleman's Magazine*,  
5 December 1805.

THE Army epidemiologist is blessed with a work environment wherein two institutionalized, independently-operated data systems record the same phenomenon—occurrence of death. This happenstance provides the rare opportunity to ascertain the reliability of mortality reporting and thus study the integrity of one of epidemiology's most basic and trusted vital statistics.

Both the Office of the US Army Surgeon General (OTSG) and the Office of the US Army Adjutant General (OTAG) operate and maintain electronic data processing systems, which include as input the personal identifiers and related information on all deaths of the Army active duty soldiers. These two data systems are separate and distinct from each other, arising from differing sets of requirements and performing different missions. Input data are collected by different individuals, using different documents. The workers who operate the systems are organizationally and spatially located in two separate Army agencies.

The medical data base was begun electronically in 1971 and is described in Army Regulation 40-400.<sup>1</sup> It is referred to as the Individual Patient Data System (IPDS). Casualty accounting is mandated by OTAG's Organization and Functions Manual<sup>2</sup> and is accomplished by what is known as the Casualty Information System (CIS). Its master file contains all Army casualties from 1961 forward.

The purpose of this paper is to describe the extent of correspondence found in death occurrences extant in these two independent reporting systems, covering the same population for the same period of time. A subsidiary purpose is to describe similarly the agreement on suicide as a cause of death in the identical population.

## Method

A magnetic tape containing the IPDS data on each Army active duty member who died during the period from 1 January 1975 through 31 December 1976 was requested and received from the Patient Administration Office of OTSG. A computer printout of a portion of the master file of CIS, listing the Army active duty individuals who died during the same period, was requested and received from the Casualty Services Division of OTAG.

Data on the IPDS tape were processed by using equipment at The Computer Center, Division of Computer Re-

search and Technology, National Institutes of Health, Bethesda, Maryland. Processing the tape resulted in a computer printout, which listed the contents of the IPDS file for all those Army active duty persons who died during the two-year period studied.

To accomplish the task of tabulating those individuals common to either death list and those individuals unique to either death list, the two computer printouts, each ordered sequentially by Social Security Administration number (SSAN), were inspected by hand.

The only personal identifier common to both IPDS and CIS is the SSAN. (CIS contains the individual's name, but IPDS does not.) Consequently, SSAN identity was used as the first criterion in establishing coexistence on either list. When SSANs were very similar but not identical, the date of death, grade, and age date were consulted to decide the question of identity.

IPDS deaths were attributed to suicide when a code of "4" (= intentionally self-inflicted injury) had been assigned to the variable *Type Case: Injury Category*. CIS deaths were tallied as suicides when a code of "B" (= intentionally self-inflicted injury) appeared under the variable *Major Attributing Cause*.

A third list of soldier suicides for the same two-year period was also available for comparison. Dattel and Johnson<sup>3</sup> reported on what they believed to have been all Army active duty suicides during calendar years 1975 and 1976. Their suicide cases accumulated as a result of OTAG's administrative policy that all cases labeled suicide by the line of duty investigatory procedures be reviewed by the Psychiatry Consultant in OTSG, for an official opinion on the deceased's mental competence. This third list of suicides is referred to herein as the D and J list.

TABLE 1

NUMBER OF SOLDIERS REPORTED AS HAVING DIED DURING CALENDAR YEARS 1975/1976 BY THE INDIVIDUAL PATIENT DATA SYSTEM (IPDS) AND BY THE CASUALTY INFORMATION SYSTEM (CIS)

|                       | Death reported by IPDS |             | Total |
|-----------------------|------------------------|-------------|-------|
|                       | Yes                    | No          |       |
| Yes:                  | 1561 (63.5%)           | 617 (25.1%) | 2178  |
| Death reported by CIS |                        |             |       |
| No:                   | 267 (10.9%)            | 13* (0.5%)  | 280   |
| Total:                | 1828                   | 630         | 2458  |

\*These are the 13 deaths appearing on the D&J list<sup>3</sup> and not found on either IPDS or CIS death lists. It is unknown how many additional deaths occupy the No/No cell. When the method presented by Chandrasekar and Deming<sup>4</sup> is used to estimate the size of the No/No cell from the information contained in the other three cells, the result is 106. If the 13 cases are replaced with the estimated 106 cases, the total number of deaths for 1975/1976 jumps from 2458 to 2551.

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TABLE 2

VARIATIONS IN THE ANNUAL UNITED STATES SOLDIER MORTALITY RATE FOR THE SAME WORLDWIDE POPULATION FOR THE SAME TWO-YEAR PERIOD

| Source of Death Count  | Number of Deaths | Annual Mortality Rate |
|------------------------|------------------|-----------------------|
|                        |                  | per 100,000*          |
| IPDS (OTSG)            | 1828             | 116.9                 |
| CIS (OTAG)             | 2178             | 139.3                 |
| IPDS and CIS           | 2445             | 156.4                 |
| IPDS, CIS and D&J      | 2458             | 157.2                 |
| IPDS, CIS and estimate | 2551             | 163.1                 |

\*Based on the two-year strength figure of 1,563,750.<sup>5</sup>

### Findings

#### Mortality Enumeration

The IPDS file contained 1,836 soldier deaths for the years 1975 and 1976 combined. Duplicate or near-duplicate records were present for eight persons. After these duplicates were deleted, the resultant death count from the Army medical data base, therefore, was 1,828.

The CIS death listing contained 2,237 entries for the two-year period. However, 59 entries were duplications, so the net death count according to TAGO's accounting system was actually 2,178.

Common to both death lists was a total of 1,561 persons. Appearing on one list only was a total of 884 persons, 267 of whom were unique to the IPDS list and 617 of whom were present only on the CIS list.\*\* Thirteen additional deaths appeared on the D and J suicide list and were not found in either IPDS nor CIS. Unknown is how many deaths beyond the enumerated total of 2,458 occurred in the Army during 1975 or 1976 and were recorded on none of the three lists. These mortality counts are arrayed in Table 1 and the percentages of the total deaths reported are presented for each cell in the matrix.

The variation in soldier mortality rate produced by these inconsistencies in death count can be seen in Table 2. The combined 1975-1976 mid-year active duty Army strength was obtained from DOD OASD (Comptroller).<sup>5</sup>

#### Suicide Enumeration

Datel and Johnson<sup>3</sup> reported 255 cases of Army active duty suicide for the years 1975-1976. IPDS was found to contain 132 deaths labeled as due to intentionally self-inflicted wounds, and CIS contained 172 such deaths for the same two-year period. These three lists produced a total of

302 individuals whose death was reported as suicide by one or more of the three tabulators. Tables 3 and 4 enumerate and array the suicide counts from the three lists, in such a manner as to illustrate the extent to which a case labeled as suicide on one list appeared also as a suicide on one or both of the other lists.

The question may also be asked, "Given the appearance of suicidal death on one of the lists, to what extent did the deceased appear as a death at all (i.e., due to any cause whatsoever) on the other death lists?" Table 5 answers this question by presenting the number and per cent of the suicides appearing on one list who also appear, first, as a suicide on IPDS and on CIS and, second, as a death at all on IPDS and on CIS.

These reliability data can be further elaborated by noting that, of the 302 soldiers whose death was labeled as suicide by one or more of the three tabulators, only 236 (78.1 per cent) appeared as a death at all on the IPDS list and only 248 (82.1 per cent) were found as a death due to any cause whatsoever on the CIS list.

The varying suicide counts produce a greater than two to one difference in the range of resultant annual suicide rates (Table 6).

### Discussion

How many American soldiers died during the years 1975 and 1976? The Adjutant General reported 2,178 deaths, some 16 per cent more than the Surgeon General count of 1,828. Together, both systems reported 2,445, a gain of 11 per cent over the highest single-system count. Thirteen more deaths, not recorded in either CIS or IPDS, were also discovered.

There was only 63.5 per cent commonality in the mortality lists of the two independent electronic data processing systems studied. The casualty reporting system contained 89 per cent of the 2,458 total (?) deaths, and the medical data base contained only 74 per cent of the total number of deaths. These results are judged to represent an unsatisfactory degree of reliability for scientific purposes. Presumably, they are also unsatisfactory for administrative, planning, or legal use of the information, as well.

In response to these findings, two principal questions arise: What are the reasons for the discrepancy in death count? What are the implications of such results?

TABLE 3

THE DISTRIBUTION BY WHICH 302 SOLDIER DEATHS, LABELED AS SUICIDE BY ONE OR MORE OF THREE LISTS, APPEARED ALSO AS A SUICIDE ON ONE OR MORE OF THE THREE LISTS

| Appeared as a suicidal death on: | Number | Per cent |
|----------------------------------|--------|----------|
| One list only                    | 113    | 37.4     |
| Uniquely D&J: 70                 |        |          |
| Uniquely IPDS: 26                |        |          |
| Uniquely CIS: 17                 |        |          |
| Two lists only                   | 121    | 40.1     |
| Uniquely D&J/IPDS: 34            |        |          |
| Uniquely D&J/CIS: 83             |        |          |
| Uniquely IPDS/CIS: 4             |        |          |
| All three lists                  | 68     | 22.5     |
| Total                            | 302    | 100.0    |

\*\*In performing the manual search for commonality and uniqueness between the two death lists, there occurred 69 cases in which the SSANs did not match each other exactly, but which were classified as identities because of sufficient correspondence between date of death, age, and grade data. It is important to note that, had the SSAN been used as the sole criterion for agreement, these 69 cases (2.8 per cent) would have been misclassified as "uniques" and the total death count would have risen accordingly.

TABLE 4  
SUICIDE LABELING COMMONALITY BETWEEN PAIR COMBINATIONS OF THREE LISTS\*

|       | D&J         | IPDS        | CIS         |
|-------|-------------|-------------|-------------|
| D&J:  | 255 (84.4%) | 102 (33.8%) | 151 (50.0%) |
| IPDS: |             | 132 (43.7%) | 72 (23.8%)  |
| CIS:  |             |             | 172 (57.0%) |

\*Percentages based on N = 302 = number of soldier deaths labeled as suicide by one or more of the three lists.

### Reasons for Unsatisfactory Reliability

One can rationalize several possibilities, or their combination, to account for the inconsistency in death tallies between IPDS and CIS: (a) There was outright fraudulent reporting of death into one system, but not into the other (invalid reporting); (b) there was mistaken reporting of death into one system, but not into the other (invalid reporting); (c) personal identifiers attached to the deceased differed from one system to the other (misidentification reporting); (d) individuals were categorized incorrectly by one of the systems (misclassification reporting); and (e) deaths were recorded validly and accurately in one system but were not recorded at all in the other (incomplete reporting).

If the error were of the (a) or (b) variety, the person who was called dead was actually alive. If the error were (c), the person called dead was indeed dead, was accounted for in either system, but was misidentified in at least one of the two systems. If the error were (d), the person called dead was indeed dead, but his military status was incorrectly recorded in one of the two systems. If the error were (e), the person called dead was indeed dead, but one of the two systems contained no record of the death.

Misidentification reporting was observed to have been operative in the 69 instances wherein social security numbers did not agree, but other identifying information did agree. Other instances of mistaken disagreement in social security numbers may have gone undetected. Matching cases which contain errors in personal identifiers is a technical problem, made unnecessarily difficult in this instance by the failure of IPDS to include the individual's name as a data element in the system. Studies such as the one at hand reveal the flawed wisdom in withholding names from the files of person-based data, when designing a general purpose medical information system.

Misclassification reporting is also known to have contributed to the imperfect correspondence between the two death lists. It was observed that some soldiers suffering from a terminal illness were medically retired from the Service just prior to their expectant deaths, but their IPDS files indicated that they died while on active duty. Such instances represent an unknown proportion of the 267 individuals recorded as deaths in IPDS, but not found as active duty deaths in CIS.

It seems quite probable that a goodly portion of the discrepancy between the two death lists was due to incomplete reporting—by either system. This finding, although

circumscribed as it is here to the military, raises the question of death count coverage in general.

The completeness of death reporting within the United States as a whole has not been well-studied. It is known, however, that some deaths each year go officially unnoticed. Some fetal and infant deaths and some cases of homicide are never registered. Also, there have apparently been instances in which states have reported some deaths too late for them to get entered into the official count tallied annually by the Nation Center for Health Statistics. While this proportion of unregistered or unreported deaths in the United States is assumed to be small, it is unknown.<sup>6</sup>

When the reliability of death tabulation has been formally studied in other countries, the results have been surprisingly similar to what I report here—at least in two instances. Glass<sup>7</sup> compared two separate death registries, each compiled for London for the years 1696 to 1699, parish registration entries versus special tax collector records. He found that, out of a total of 3,922 deaths, 611 were unique to the tax collector records and 1,058 were unique to the parish registries. This represents only 57.4 per cent commonality. Thomlinson<sup>8</sup> studied a dual record system for the recording of deaths in Morocco in 1972. Out of a total of 75 deaths, only 39 persons could be successfully matched from the two death lists. This is 52.0 per cent commonality. Razzell<sup>9</sup> offers a number of reasons for what he observes to have been large-scale under-registration of deaths in 19th-century England. Computer technology notwithstanding, the present-day picture may not be significantly better.

A death event will go unreported as such for official and historical purposes if it: (a) goes unregistered; (b) is registered but is not forwarded; or (c) is registered and forwarded but is not recorded statistically. From the point at which a person is observed to have expired to the point that the deceased is represented as an increment of one in the vital statistics archives, a rather complex, interdependent chain of events must properly unfold. In the study being reported here, something obviously went askew in this chain of events. To what extent such a chain of events is broken in other contemporary settings is unknown.

It is not the purpose of this paper to diagnose the system deficiencies which created the results obtained. However, such a painstaking endeavor needs to be the next step, not only for system integrity but for understanding the human engineering issues behind the inconsistencies detected. For example, it would appear that the trouble-shooting process will need to concern itself with the question, "What consequences are attached to the reporter for reporting and for not reporting deaths?" Given the data obtained here, it becomes no longer possible to assume that issuance of a directive is tantamount to performance of the behavior directed, or that a cooperative agreement results in the behavior agreed upon.

### Implications of Unsatisfactory Reliability

Some of the implications of an unreliable death record system are painfully obvious and need not be delineated. For the epidemiologist, the most destructive implication is the one of suspicion. If mortality cannot be counted reliably, how then must go morbidity? As regards death, we have quite hard criteria for case definition; case finding in mor-

TABLE 5

THE EXTENT TO WHICH DECEASED SOLDIERS LABELED AS DEATH BY SUICIDE BY ONE REPORTING SYSTEM ARE SO LABELED BY ANOTHER REPORTING SYSTEM, AND THE EXTENT TO WHICH SUCH SUICIDES ARE CAPTURED AS A DEATH AT ALL BY THE OTHER REPORTING SYSTEM(S)

| Number of Suicides on List | Appear on IPDS<br>as |           | Appear on CIS<br>as |           |
|----------------------------|----------------------|-----------|---------------------|-----------|
|                            | Suicide              | Death     | Suicide             | Death     |
| D&J: 255                   | 102 40.0             | 195 76.5  | 151 59.2            | 214 83.9  |
| IPDS: 132                  | 132 100.0            | 132 100.0 | 72 54.5             | 102 77.3  |
| CIS: 172                   | 72 41.9              | 129 75.0  | 172 100.0           | 172 100.0 |

bidity is much more influenced by observer differences. How reliable are our counts of mental illness? Of hypertension? Of battle wounds?

Attribution of suicide is a cause of death question—not unlike matters of differential diagnosis. To ask how reliable was the obtained count on suicide, then, is to inquire into data reliability on a matter akin to that involved in the study of morbidity. The results give little cause for rejoicing.

Of 302 persons labeled suicide by at least one of the three record systems, unanimous agreement on suicide as the cause of death occurred for only 22.5 per cent of the cases. In 40 per cent more instances, two of the three lists agreed with each other. Thirty-seven per cent of the time, the person appeared as a suicide on only one of the three lists.

Considering IPDS and CIS only, a total of 232 persons were labeled as suicides by one or both of the two systems. Of this number, only 72 (or 31 per cent) were mutually labeled as suicide by the two systems.

Even more discouraging was the finding that, of the 132 persons labeled suicides by IPDS, only 77 per cent could be found in CIS as having died at all; and, of the 172 persons labeled suicides by CIS, only 75 per cent could be found in IPDS as having died at all.

Finally, the question arises as to whether the death omissions from IPDS and from CIS were systematic or random. If the death omissions were systematic, say with respect to age, grade, race, or cause of death, the data would produce not only a depressed mortality rate but an unrepresentative picture of the demography of the mortality. Such information accumulated over time could be quite misleading to medical investigators and planners.

The conclusion is reached that the level of agreement in a

TABLE 6

VARIATIONS IN THE ANNUAL UNITED STATES SOLDIER SUICIDE RATE FOR THE SAME WORLDWIDE POPULATION FOR THE SAME TWO-YEAR PERIOD

| Source of Suicide Count | Number of Suicides | Annual Suicide Rate |
|-------------------------|--------------------|---------------------|
|                         |                    | per 100,000*        |
| IPDS                    | 132                | 8.4                 |
| CIS                     | 172                | 11.0                |
| D&J                     | 255                | 16.3                |
| IPDS, CIS AND D&J       | 302                | 19.3                |

\*Based on the two-year strength figure of 1,560,750.<sup>5</sup>

two-year soldier mortality count between two parallel electronic data processing systems in the US Army is unacceptable for epidemiologic purposes. The low level of agreement is most probably due to incomplete reporting by either system. It is further concluded that, when epidemiologic counts are made on health events other than simple death tabulations, for example on cause of death due to suicide, the reliability between the systems compared drops even lower.

The results of the study imply that a scientific requirement exists to conduct periodic reliability checks on epidemiologic data inserted into and contained within modern electronic data processing systems. When reliability reaches unsatisfactory levels, as in the present study, responsible agencies are thereby alerted and system examination, repair, and, if necessary, redesign are instigated.

### Summary

The extent of agreement in soldier death count between two independent electronic information systems in the US Army, one medically-based and the other personnel-based, was studied for calendar years 1975 and 1976 and was found to be unsatisfactory for epidemiologic purposes. The two death lists shared only 63.5 per cent commonality in the total mortality count of 2,458 cases. Agreement in suicide labeling was also studied and found to be even lower.

Possible reasons for the discrepancies are discussed, and implications of such low reliability for military epidemiology are drawn. It is unknown whether the low reliability found in the military setting is also a significant problem in the United States in general, but it was learned that death enumeration is not a new problem to the English-speaking world.

### Acknowledgments

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