

STATISTICAL SYSTEMS IN ANESTHESIOLOGY

MEYER SAKLAD, M.D., AND PRISCILLA SELLMAN, M.D.

Providence, R. I.

THE Committee on Records of the American Society of Anesthesiologists has developed methods for the compilation of statistics in the fields of Anesthesia, Inhalation Therapy and Therapeutic and Diagnostic Block. These methods were designed to satisfy the requirements of those interested in conducting scientific surveys in any or all of the above subjects (1, 2).

The statistical setups as devised meet statistical requirements inasmuch as they allow for the consideration and compilation of many variables and make it possible to correlate a great many case studies mechanically. This is accomplished by the use of the Hollerith Punch Card Method. A uniform code with a common interpretation makes it possible to pool the case studies of several workers. Thus, a very large series can be compiled. When many variables must be considered a reasonably accurate survey must depend upon study of very many patients.

Codes have been completed and are assembled in one booklet. They are available through the offices of the above named society. Three sets of punch cards, one for each of the studies mentioned, have been devised and may be purchased in lots of 2,000 from the International Business Machines Corporation. The cards may be distinguished by the printing upon them and by their characteristic corner cuts. The card for Anesthesia is numbered 700119 and has the upper left hand corner removed. The card for Inhalation Therapy is numbered 741525 and is minus the upper right corner. The card devoted to the study of Therapeutic and Diagnostic Block is marked 741526 and has no corners cut. The corner cuts enable the cards to be regrouped readily after having been stacked together.

Each of the setups has its characteristic fields of study (figs. 1a, 1b, 1c). An attempt was made to have as much uniformity as possible in the fields of the three plans.

Under each of these fields, tables of variables were drawn up. Each of these variables was assigned a code number. The code numbers were so grouped that main subdivisions of the types of variables have one or more digits in common.

The grouping of variables is such that there is left room for change and expansion in the code as the case may be.

In designing these tables of variables it was deemed necessary to define arbitrarily some of the variables. It was also necessary that in

some instances new terminology should be coined, a new classification devised and an already accepted classification extended.

Some of the tables of variables are common to all three studies and some to two. A few of the tables are to be used in only a single study.

TABLE 1
VARIABLES

<i>General Codes</i>	<i>Codes Special to Inhalation Therapy</i>
Month	Indications
Age	Grades of Hypoxia
Sex	Method
Physical State	Auxiliary Treatment
Agents	Conditioned Atmosphere
Efficacy	<i>Codes Special to Therapeutic and Diagnostic Block</i>
Condition on Discharge	Blocks
Diagnosis and Complications	Purpose of Block
<i>Codes Special to Anesthesia Data</i>	Vehicle
Premedication	Associated Therapy
Methods	Number of Blocks to Date
Anesthesia Plane or Extent	Total Number of Blocks
Reason	
Anesthesia Time	
Operations	
Time of Complication and Death	

In the booklet they are divided into General Codes, Codes Special to Anesthesia Data, Codes Special to Inhalation Therapy and Codes Special to Therapeutic and Diagnostic Block (table 1).

GENERAL CODES

Geographic: A two digit number is assigned to each of the users of the code. This number when recorded on the card identifies the individual or the institution which uses the system.

Case Number: A number of five digits is entered here to identify the case record. When the hospital or case number exceeds five digits, the last five are recorded.

Month: This is a single digit column of the ten digits and with the letters X and Y. The latter two denote November and December, respectively.

Year: The last two digits of the year are recorded here.

Age: A single digit column is here employed with years divided into decades.

Sex: The digit 1 is used for males and 2 for females.

Physical State: This is a single column code used to designate the condition of the patient. This category is not to be confused with what is ordinarily termed "Operative Risk." Herein is considered only the patient's physical state. The contemplated operative procedure or other factors do not enter into the evaluation (3). Seven grades of Physical State are considered (table 2).

Agents: A two digit number obtained from the table of Agents is employed. This table lists all the agents, whether used in anesthesia, inhalation therapy or in therapeutic and diagnostic block. In the Anesthesia study three anesthetic agents may be recorded. They are recorded, not in the sequence in which they are employed, but as to the depth or plane to which the patient has been carried. The more potent agents are recorded first.

TABLE 2

DIVISION OF PHYSICAL STATE INTO SEVEN GRADES

1. An individual with no organic disease or with localized disease which causes no systemic disturbance.
This category includes patients suffering from fractures, unless there is blood loss or shock; congenital deformities unassociated with systemic disturbance; localized infections that do not cause fever or other illness; orthopedic deformities and uncomplicated hernias. The type of operation has no influence upon the gradation of Physical State.
2. An individual with moderate systemic disturbance.
Examples: Mild diabetes; mild acidosis; moderate anemia; pharyngitis; chronic sinusitis; early incarcerated hernia.
3. An individual with severe systemic disturbance.
Examples: Poorly controlled diabetes; intestinal obstruction sufficiently advanced to have caused serious physiologic disturbance; pulmonary tuberculosis with reduced vital capacity; severe trauma.
4. An individual suffering from systemic disorders which are an imminent threat to life.
Examples: Severe trauma with irreparable damage; severe intestinal obstruction of long standing; advanced cardiovascular disease.
5. All patients who are operated upon for emergency conditions who would otherwise be in classes 1 or 2.
6. All patients who are operated upon for emergency conditions who would otherwise be in classes 3 or 4.
7. All patients who are moribund.

Efficacy: This is a single column code which is to be used in the Inhalation Therapy and in the Therapeutic and Diagnostic Block studies.

Condition on Discharge: A single digit code to be made use of in the Inhalation Therapy and the Therapeutic and Diagnostic Block codes is employed.

Diagnosis and Complication: This is a three column code. From this table of variables are obtained the code numbers for Preoperative Complication, Operative Complication, Postoperative Complication and Cause of Death for the anesthesia study. It must be noted that under Preoperative Complications are to be listed only those variables which have altered the patient's physical state from Grade 1. Under Operative Complications are listed phenomena which may have occurred to the patient as the result of the anesthesia or operation. Under Postoperative Complications is entered the occurrence of a new disease or the aggravation or extension of a condition already present. Cause of Death is also obtained from this listing. It is important to note that only those variables marked with an asterisk may be employed for Cause of Death.

For the Inhalation Therapy study the code numbers on Diagnosis and Complications may be employed for Diagnosis, Complications to Therapy and Complications to Disease.

From this table are also obtained the coded variables for use in the Therapeutic and Diagnostic Block study for Diagnosis, Indication, Complications to Block and Complications to Disease.

CODES SPECIAL TO ANESTHESIA

Premedication: A two column code is employed. A premedicant drug may be recorded by itself or in usual combinations with others.

Methods: Here a code of two digits is used by means of which the method of anesthesia is recorded. Since more than one anesthesia method may be employed in a given case there is room to record up to three different methods. Methods are not necessarily recorded in the sequence in which they are used. They are entered into the same subfields as the agent with which it is associated. See "Agents."

Anesthesia Plane or Extent: This is a single column code used to denote the plane of anesthesia, the extent of spinal anesthesia and the effectiveness of regional anesthesia.

Reason: A single digit code is made use of to obtain the reason for the use of the agent or method employed. Here it is possible to record the fact that the anesthesia was the choice of the anesthetist or was administered at the surgeon's request or was used because of an unsatisfactory regional anesthesia, etc.

Anesthesia Time: A table of arbitrarily chosen intervals of time represented by a single column code denotes the period from the beginning of anesthesia to the termination of the operation.

Operations: This is a three column code listing most of the operative procedures. The code numbers are so distributed that the first digit locates the operative area. The second digit further defines the operative procedure into a subclassification.

Time of Complication and Death: From a table of arbitrarily defined intervals is chosen the proper code number to be placed along side a postoperative complication or the cause of death to show the time of its occurrence.

CODES SPECIAL TO INHALATION THERAPY

Indication: The indication for inhalation therapy is either the form of hypoxia from which the patient is suffering or other indications as "nitrogen removal" or "changes in atmospheric pressure." Conditions of oxygen lack have been grouped under seven types of hypoxia (table 3). The disease from which the patient is suffering is entered under Diagnosis and the form of hypoxia under Indication. Thus, lobar pneumonia is recorded as 721 under Disease and 301 under Indication. Tables of diseases in their proper groups of indications are to be found in the code book.

TABLE 3

SEVEN FORMS OF HYPOXIC STATES

Atmospheric Hypoxia:	Oxygen want resulting from a decrease in the partial pressure of oxygen in the respired atmosphere.
Tidal Hypoxia:	Oxygen want because of a decrease in the minute volume exchange.
Alveolar Hypoxia:	Oxygen want resulting from a decrease in the number of functioning alveoli.
Hemoglobin Hypoxia:	Oxygen want resulting from a decrease in the oxygen carrying capacity of blood.
Demand Hypoxia:	Oxygen want because of an uncompensated increase in oxygen requirement.
Stagnant Hypoxia:	Oxygen want resulting from a decreased circulatory efficiency.
Histotoxic Hypoxia:	Oxygen want because of an impaired ability of tissue to utilize oxygen.

Grades of Hypoxia: The degree of hypoxia is defined as of four grades (table 4). Each of these has a code number of from one to four. In the absence of hypoxia a zero is entered in this column.

TABLE 4

GRADES OF HYPOXIA

Hypoxia, Grade I

Over-confidence, restlessness, nausea, headache, impaired judgment, impaired vision, dizziness, weakness, increased respiratory rate, increased pulse rate.

Hypoxia, Grade II

Vomiting, anxiety, muscle incoordination, twitching, elevated temperature, mental confusion, marked increase in respiratory rate, rise in blood pressure, air hunger, cyanosis.*

Hypoxia, Grade III

Unconsciousness, convulsions, slow, full and bounding pulse, slowing respiration, irregular respiration, fall in blood pressure, cyanosis.*

Hypoxia, Grade IV

Coma, respiratory arrest, circulatory collapse, asphyxia pallida.

* The presence of cyanosis is dependent upon the amount of hemoglobin, type of skin, and the condition of the peripheral circulation.

Method: A code number of three digits records the means by which inhalation therapy was administered. The first of the three digits denotes the apparatus employed. The second digit is a record of the presence or absence of carbon dioxide in the inhaled gas mixture. The third digit has reference to the use of differential pressures.

Auxiliary Treatment: This is a single digit code to record associated therapy as tracheobronchial toilet, oropharyngeal airway, etc.

Conditioned Atmosphere: Here, by means of a single digit code, may be recorded temperature alterations or pollen filtration of the respired atmosphere. If none is employed a zero is entered in this column.

CODES SPECIAL TO THERAPEUTIC AND DIAGNOSTIC BLOCK

Blocks: A code of three digits denotes the nerves or areas involved in the procedure.

Purpose of Block: A single number code is used to record whether the block procedure was administered for therapeutic, diagnostic or prognostic reasons.

Vehicle: A code of a single digit denotes whether the agent was in water, saline solution or oil.

Associated Therapy: Here is recorded by means of two digits whether chemotherapy, anticoagulants, etc., were associated with the block in the therapy.

Number of Blocks: Two digit numbers must be employed. If the number of blocks is less than 10 a zero is placed before the number. In the area marked Blocks to Date is inserted the number of the block that this card represents. In the area Total Blocks is recorded the total number of blocks the patient received for the condition for which treatment was given. This latter number is inserted *after* the therapeutic procedure has ended. Thus, in a card marked 1 in the Blocks to Date and 1 in the Total Blocks we will know that but one block was done. If in the space Blocks to Date appears the number 2 and the Total Blocks is marked by a 5 we will know that this card represents the second in a series of five blocks. It is thus possible to distinguish the number of patients treated, the number of blocks done and the number of blocks that each patient received.

In addition to the fields enumerated, there remain Anesthetist, Surgeon and Referring Service. These are private codes and are drawn up to suit the needs of the user. Referring Service is limited to twelve subdivisions, whereas the other two are unlimited.

The coded variables may be written directly on the card or upon an intermediary form, such as an anesthesia chart devised for this purpose (1) or on a specially drawn up study sheet (2). Eventually the numbers are entered in their proper areas on the punch card. When a sufficient number of cards has been thus coded they are ready for punching. The cards are so drawn up that when put in a punching machine the coded variables are in view for punching. Punching is begun on column 10 unless the first 9 columns are desired to be used for special additional information.

Figures 2, 3 and 4 are coded cards of hypothetical case studies for Anesthesia, Inhalation Therapy and Diagnostic and Therapeutic Block.

By reading the code numbers on the anesthesia card one obtains the following information:

The anesthetic was administered in the Rhode Island Hospital by anesthetist number 11 and the patient was operated upon by surgeon number 804. The case number is 97842. In June 1945 a female in her eighth decade of life came to surgery in poor physical state. Pre-operatively she was suffering from diabetic acidosis, empyema of the gallbladder and marked obesity. She received as preoperative medication morphine and scopolamine. The main anesthetic agent was

INHALATION THERAPY - APRIL 1945

<p>NAME THOMAS SMITH</p> <p>1 CODE 1 11</p> <p>2 SEX M 01056</p> <p>3 AGE 7 744</p> <p>4. HGT 5 FT 3 IN 313</p> <p>5 WT 145 LBS 451</p> <p>6 HAIR BRN 222</p> <p>7 EYES BLU 01</p> <p>8 COMPLEXION 70</p> <p>9 OCCUPATION 01</p> <p>10 MARITAL STATUS 01</p> <p>11 RELIGION 000</p> <p>12 ETHNICITY 470</p> <p>13 HOSPITAL</p>	<p>14 SERVICE CENTER 0100</p> <p>15 HOSPITAL X000</p> <p>16 ROOM 0</p> <p>17 BED NO. 2</p> <p>18 ADMITTED 1</p> <p>19 DISCHARGED 9</p> <p>20 ANESTHETIST 43</p>	<p>REMARKS</p>
<p>NAME THOMAS SMITH</p> <p>1 CODE 1 11</p> <p>2 SEX M 01056</p> <p>3 AGE 7 744</p> <p>4. HGT 5 FT 3 IN 313</p> <p>5 WT 145 LBS 451</p> <p>6 HAIR BRN 222</p> <p>7 EYES BLU 01</p> <p>8 COMPLEXION 70</p> <p>9 OCCUPATION 01</p> <p>10 MARITAL STATUS 01</p> <p>11 RELIGION 000</p> <p>12 ETHNICITY 470</p> <p>13 HOSPITAL</p>		

FIG. 3. Inhalation therapy. Hypothetical case study.

DIAGNOSTIC & THERAPEUTIC BLOCK - APRIL 1945

NAME JANE DOE	SERVICE OR HOSPITAL 317	ROOM 317	HOSP. NO.
1. CODE 111	2. CASE NO. 00867	3. DATE 7 4 5	4. AGE 6
5. SEX 4	6. PHYSICIAN 2	7. STATUS 854	8. OCCASION 276
9. POSITION 1	10. TIME 30	11. BLOCK 900	12. ANESTHETIC 000
13. ANESTHETIC 000	14. COMPLICATION 000	15. BLOCKS TO DATE 02	16. TOTAL HOURS 03
17. VEHICLE 0	18. EFFICIENCY 2	19. COMPLICATIONS 2	20. INTERFERE 3
21. ANESTHETIST 24	REMARKS		
[REMARKS AREA]			

FIG. 4. Diagnostic and therapeutic block. Hypothetical case study.

cyclopropane-oxygen. It was administered endotracheally by closed circuit with carbon dioxide absorption. It was preceded by topical application of cocaine to the larynx. The relaxation was inadequate and curare was administered intravenously. During anesthesia a moderate degree of laryngospasm and bradycardia developed. The operative procedure was cholecystotomy and took between thirty and sixty minutes. Between her fourth and seventh day postoperatively lobar pneumonia developed. She died of lobar pneumonia between her eighth and fourteenth day postoperatively.

Figure 3 represents a case of inhalation therapy. The case number is 1056. In addition to telling us in what institution this patient was treated and by whom, we learn from the card that a male in the third decade of life in poor physical condition received inhalation therapy in July 1944. The diagnosis was overdose of anesthetic. The anesthetic agent was tribromethanol. Oxygen was administered by intermittent positive pressure through an endotracheal tube in closed circuit with carbon dioxide absorption. Tracheobronchial toilet was carried out and the therapy did not last longer than that day. The intubation was traumatizing. There were no further complications to the therapy nor to the condition from which he was suffering. The amount of oxygen used was not measured. The therapy was beneficial and the patient was well on discharge.

Figure 4 represents case number 867. In July 1945 a female in her sixth decade of life in fair physical state was treated for carcinoma of the cervix. She was suffering from nerve involvement owing to spread of the disease. The therapy was instituted for the relief of pain. The therapeutic procedure was the administration of alcohol intrathecally. There was no further associated therapy. The procedure was complicated by a difficult lumbar tap. There was no additional complication to the disease from which she was suffering. This procedure was the second of a series of three. The alcohol was not administered with any other agent. The therapeutic procedure was beneficial and the patient was discharged improved. The patient was referred by the gynecologic service and the therapy was carried out by anesthetist number 24.

Figures 5, 6 and 7 show the completed cards already punched and ready for sorting. The cards are sorted when a sufficient number of case studies has been completed in each of the categories to warrant investigation. The cards are, of course, kept divided as to whether they are for Anesthesia, Inhalation Therapy or Diagnostic and Therapeutic Block.

Cards may be sorted to discover simple facts such as the number of cases of a certain type over a given period, the number of certain procedures carried out by a definite department or individual.

Intercorrelation may be employed for statistical purposes. Example: To determine the occurrence of pulmonary complications post-

NAME **MARY JONES** SERVICE OR HOSPITAL ROOM **C** HOSP. NO. _____

1	DEOC	1 1 1												
2	CASE NO.	9 7 8 4 2												
3	MO AND YR.	6 4 5 3												
4	PRIO. COMP.	8 1 1 5 3 2 8 0 1												
5	DATE	8 1 1 5 3 2 8 0 1												
6	TIC. NO.	2 6												
7	INST.	1 2 3 4 2 0												
8	ANST. AGENT	8 0 4 0 2												
9	INST. METHOD	4 0 6 0 0												
10	OP. COMP.	7 4 3 1 6 1												
11	OPER.	3 0 3												
12	AN. TIME	3												
13	P.O. COMP.	7 2 1 3 0 0 0 0 0 0												
14	LEA. TIME	7 2 1 4												
15	ANESTH.	1 1												
16	SURGEON	8 0 4												
17	HOSPITAL	8 0 4												
18	REMARKS													
19	REMARKS													
20	REMARKS													

Fig. 5. Anesthesia card, control and attached.

INHALATION THERAPY - APRIL 1945

NAME THOMAS SMITH		SERVICE OR HOSPITAL		ROOM 107		HOSP. NO.	
1. SEX M	2. CASE NUMBER 470	3. DATE 4-15-45	4. TIME 10:00	5. PHYSICIAN SMITH	6. NURSING 3	7. ROOM 107	8. HOSPITAL 107
9. DATE OF BIRTH 4-5-1	10. NAME SMITH	11. METHOD 9-5-6	12. DURATION 0-1	13. EFFICACY 3	14. COMMENTS 1	15. COMMENTS 0-0-0	16. COMMENTS 0-0-0
17. COMMENTS 4-5-1	18. COMMENTS 2-2-2	19. COMMENTS 0-1	20. COMMENTS 7-0	21. COMMENTS 4-7-0	22. COMMENTS 0-0-0	23. COMMENTS 0-0-0	24. COMMENTS 0-0-0
REMARKS							
[REMARKS SECTION WITH VARIOUS MARKS AND NOTATIONS]							

FIG. 6. Inhalation therapy card, coded and punched.

DIAGNOSTIC & THERAPEUTIC BLOCK- APRIL 1945

<p>NAME JANE DOE</p> <p>1 SEX 1 2 CASE NO 00867 3 DATE 7 4 5 4 AGE 6 5 SEX 2 6 PHYSIC. STRIKE 2</p> <p>7. DISEASE 854 8. OCCASION 276 9. POS. 1</p> <p>10. HEM. AMBY 30 11. BLOCK 9,0,0</p> <p>12. ASSE. 00 13. CHAMBER 00</p> <p>14. COMPLICATION TO BLOCK 0,0,0</p> <p>15. BLOCKS TO DATE 0 2 0 3</p> <p>16. VEHICLE 0</p> <p>17. REFLECTY 2</p> <p>18. CONDITION OF DISCONNECT 2</p> <p>19. RETURNING TO SERVICE 3</p> <p>ANESTHETIST 2 4</p>	<p>SERVICE OR HOSPITAL</p> <p>ROOM 317</p> <p>HOSP. NO.</p> <p>REMARKS</p>	<p>HOSPITAL</p> <p>1. CLERK CODE 466 2. CASE NUMBER 000 3. DATE SET 0,0,0</p> <p>4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.</p>
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Fig. 7. Diagnostic and therapeutic block card, coded and punched.

operatively in cardiac patients in the fifth decade of life operated on for upper abdominal pathologic conditions under the various anesthetic agents and procedures.

Under Inhalation Therapy it may be desired to determine the relative efficiency of the various therapeutic procedures employed to deliver oxygen in the treatment of lobar pneumonia. It may be desired to institute a statistical research on the value of paravertebral sympathetic block by procaine in the treatment of thrombophlebitis. If a sufficient number of patients was treated for this condition and the cards properly filled out and punched, such a study would offer very little difficulty.

SUMMARY

There is now available for distribution a code book covering as far as possible all the variables necessary to institute statistical research in the fields of anesthetic and surgical morbidity, inhalation therapy and diagnostic and therapeutic block. A specially devised punch card with its own fields of distribution has been devised for each of these categories. Whenever possible, tables of variables common to two or three of the studies have been grouped together.

Each of the fields has been discussed. Cards properly filled out and punched have been presented showing hypothetical case studies. The potentialities for their use in statistical surveys have been suggested by the presentation of possible problems.

The proper execution of the method is not difficult. Familiarization with the code book and the field distributions is important. It is suggested that those who intend to employ the method first observe its use in the hands of those thoroughly familiar with it.

REFERENCES

1. Saklad, M.: A Method for the Collection and Tabulation of Anesthesia Data, *Anesth. & Analg.* 19: 184-196 (July-Aug.) 1940.
2. Saklad, M.; Gillespie, N., and Rovenstine, E. A.: Inhalation Therapy; A Method for the Collection and Analysis of Statistics, *Anesthesiology* 5: 359-369 (July) 1944.
3. Saklad, M.: Grading Patients for Surgery, *Mod. Hosp.* 55: 59 (Nov.) 1940.

COMING EXAMINATIONS

The Part II (Oral) Examinations for certification by The American Board of Anesthesiology, Inc., will be held October 9 to 15, 1946, at the Hotel Pennsylvania, New York City. Qualified candidates will be advised personally as to further details. Paul M. Wood, M.D., Secretary, 745 Fifth Avenue, New York 22, N. Y.