

Chapter 1

Introduction

1.1 Background

Medicine has been identified as a profession for the past 3000 years and today a vast sum of money is spent on health care worldwide.¹ For example, in 1997, the world market for medical devices alone was estimated to be around \$120 billion.² Humans (i.e. doctors, nurses, etc.) are a critical component of the health care system and they are subjected to errors.

Nonetheless, it may be added that human error is a fact of life. More specifically, it occurs in all aspects of life and in every job occupation with varying consequences. In addition, as in Ref. 3, an average of 60–80% of all accidents involve human error in one way or the other. Although the occurrence of human error in medicine may have been there ever since its first practice, the earliest documented medical error-related death in modern times may be traced back to 1848.^{4,5} It was associated with the administering of anesthetic.

It appears that the first serious studies concerned with medical errors were conducted in the late 1950s and the early 1960s,^{6,7} mainly focusing on anesthesia-related deaths. Since the early 1960s, a large number of publications on human error in medical system have appeared, and a comprehensive list of these publications is provided in the appendix.

1.2 Medical Error-Related Facts and Figures

This section presents the facts and figures directly or indirectly related to the subject of human error in the health care system.

- In a typical year around 100000 Americans die due to human errors.⁸ The financial impact of these errors on the US economy is estimated to be somewhere between \$17 billion and \$29 billion.⁸
- Operator errors account for more than 50% of all technical medical equipment problems.⁹
- A study of anesthetic incidents in operating rooms revealed that between 70% and 82% of the incidents were due to human errors.^{10,11}
- Human error accounts for 60% of all medical device-related deaths or injuries reported through the Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA).¹²
- In 1993, a total of 7391 people died due to medication errors in the United States alone.^{8,13}
- The annual cost of medication errors is estimated to be over \$7 billion in the United States.¹⁴
- In the interpretation of radiographs, the rates of disagreement between emergency physicians and radiologists vary from 8–11%.¹⁵
- In the emergency departments over 90% of the adverse events are considered preventable.¹⁶
- A study revealed that the annual avoidable deaths from anesthesia-associated incidents hovered between 2000 and 10000 in the United States.^{17,18}
- A study of critical incident reports, in an intensive care unit, over a ten year period (i.e. from 1989–1999) revealed that most of the incidents were due to staff errors and not equipment failures.¹⁹
- An examination of 14 Australian studies published during the period between 1988 and 1996 revealed that 2.4 to 3.6% of all hospital admissions were drug-related and approximately 32–69% were preventable.²⁰
- In the United States, the annual cost of hospital-based medication-related errors is estimated to be around \$2 billion.²¹
- Medication errors exist between 5.3% and 20.6% of all administered doses.²²
- A major Hong Kong teaching hospital administered 16000 anesthetics in one year and reported 125 related critical incidents, in which human error was an important factor (i.e. in 80% of the cases).²³
- In 1984, a study examined the records of 2.7 million patients discharged from hospitals in New York and it was found that 25% of the 98609 patients who suffered from an adverse event was the result of negligence.²⁴
- An investigation of 5612 surgical admissions to a hospital revealed a total of 36 adverse outcomes due to human error.²⁵

- In 589 anesthesia-related deaths, human error was considered to be a factor in 83% of the cases.^{6,26}
- During the period between 1970 and 1977, a total of 277 anesthetic-related deaths occurred and factors such as faulty technique (43%), coexistent disease (12%), failure of postoperative care (10%), and drug overdose (5%) were considered to be responsible for the deaths.²⁷

1.3 Terms and Definitions

This section presents some useful terms and definitions, whether directly or indirectly, related to human reliability/error in health care.^{8,28–32}

- **Human error.** This refers to the failure to perform a given task (or the performance of a forbidden action) that could result in the disruption of scheduled operations or damage to property and equipment.
- **Human reliability.** This refers to the probability of performing a task successfully by humans at any required stage in a system operation within a specified minimum time limit (if the time requirement is specified).
- **Medical technology.** This is the equipment, drugs, procedures, and the methods used by professionals working in health care institutions to deliver medical care to people. This term includes the systems within which such care is delivered.
- **Risk.** This refers to the probable rate of occurrence of a hazardous situation as well as the degree of the harm severity.
- **Accident.** This is an event that involves damage to a specified system that suddenly disrupts the ongoing or potential output of the system.
- **Adverse event.** This is an injury due to a medical intervention.
- **Human factors.** This is a study of the interrelationships between humans, the tools they employ or use, and the surrounding environment in which they work and live.
- **Continuous task.** This is a task that involves some kind of tracking activity (e.g. monitoring a changing situation).
- **Human performance.** This is a measure of failures and actions under specified conditions.
- **Human performance reliability.** This refers to the probability that a human will successfully perform all required functions subjected to specified conditions.
- **Health care organization.** This is an entity that provides, coordinates, and/or insures medical-related services for the public/people.

- **Anesthesiology.** This is a branch of the medical field that deals with the processes of rendering patients insensitive to various types of pain during surgery or when faced with chronic/acute pain states.
- **Medication error.** This refers to any preventable events that may cause or result in wrong medication use or patient harm while the medication is in the control of a patient, a consumer, or a health care professional.
- **Patient safety.** This is the freedom from accidental injury. Ensuring patient safety involves the creation of operational systems/processes that reduce the likelihood of error occurrence.
- **Fault.** This is an immediate cause of a failure.
- **Failure.** This is the inability of an item to carry out its specified function.
- **Failure mode.** This is the consequence of the mechanism through which the failure in question occurs.
- **Operator error.** This is an error that occurs when an item operator does not adhere to the correct procedures.
- **Mission time.** This is that element of uptime needed to carry out a specified mission profile.
- **Consequence.** This is an outcome of an accident (e.g. human fatalities, environmental pollution, and damage to properties).
- **Hazardous situation.** This is a condition with a potential to threaten human life, health, properties, or the environment.
- **Human error consequence.** This is an undesired consequence of human failure/error.

1.4 Useful Information on Human Reliability and Error in Medicine

This section lists down some of the books, journals, conference proceedings, and organizations which are useful in obtaining information on human reliability and error in health care related issues.

1.4.1 *Books*

Some of the books that focus on human error in health care are listed here as follows:

- Bogner, M.S. (ed), *Human Error in Medicine*, Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey, 1994.

- Spath, P.L. (ed), *Error Reduction in Health Care*, Jossey-Bass Publications, San Francisco, California, 1999.
- Kohn, L.T., Corrigan, J.M. and Donaldson, M.S. (eds), *To Err is Human: Building a Safer Health System*, National Academy Press, Washington, D.C., 1999.
- Rosenthal, M.M. and Sutcliffe, K.M. (eds), *Medical Error: What Do We Know? What Do We Do?*, John Wiley and Sons, New York, 2002.
- Mulcahy, L., Lloyd-Bostock, S.M. and Rosenthal, M.M., *Medical Mishaps: Pieces of the Puzzle*, Taylor and Francis, Inc., New York, 1999.
- Caldwell, C. and Denham, C., *Reducing Medication Errors and Recovering Costs: A Four-Step Approach for Executives*, Health Administration Press, Chicago, 2001.
- Cohen, J., *ER: Enter at Your Own Risk: How to Avoid Dangers inside Emergency Rooms*, New Horizon Press, Far Hills, New Jersey, 2001.
- Mociver, S., *Medical Nightmares: The Human Face of Errors*, Chestnut Publishing Group, Toronto, Canada, 2002.
- Youngson, R.M. and Schott, I., *Medical Blunders: Amazing True Stories of Mad, Bad, and Dangerous Doctors*, New York University Press, New York, 1996.
- Dhillon, B.S., *Medical Device Reliability: and Associated Areas*, CRC Press, Boca Raton, Florida, 2000, Chapter 4.

1.4.2 Journals

The scientific journals that contain articles directly or indirectly related to human error in medicine are as follows:

- New England Journal of Medicine
- American Family Physician
- Anesthesia
- British Journal of Anesthesia
- Canadian Journal of Anesthesia
- British Medical Journal
- Canadian Medical Association Journal
- European Journal of Anesthesiology
- Journal of Clinical Anesthesia
- Journal of American Medical Association (JAMA)
- Journal of Family Practice
- Journal of General Internal Medicine

- Journal of Nursing Administration
- Journal of Professional Nursing
- Journal of Quality Clinical Practice
- Journal of Royal Society of Medicine
- Journal of the American College of Surgeons
- Medical Device Diagnostic Industry Magazine
- South African Medical Journal
- The Lancet
- Rhode Island Medical Journal
- Drug Safety

1.4.3 *Conference Proceedings*

The conference proceedings that contain articles on human errors in medicine are as follows:

- Proceedings of the Second Annenberg Conference on Enhancing Patient Safety and Reducing Errors in Health Care, 1998.
- Proceedings of the 59th Annual Meeting of the American Society for Information Science, 1996.
- Proceedings of the Annual Human Factors Society Conference, 1998.
- Proceedings of the 17th International Conference of the Systems Safety Society, 1999.
- Proceedings of the First Workshop on Human Error and Clinical Systems (HECS'99), 1999.
- Proceedings of the First Symposium on Human Factors in Medical Devices, 1989.
- Proceedings of the AMIA Annual Fall Symposium, 1986.
- Proceedings of the 6th ISSAT International Conference on Reliability and Quality in Design, 2000.

1.4.4 *Organizations*

Some of the organizations which provide information on human error in health care are as follows:

- Institute of Medicine, 2001 Wisconsin Avenue NW, Washington, DC 20418, USA.
- American Medical Association, 515 N, State Street, Chicago, Illinois 60610, USA.

- Emergency Care Research Institute (ECRI), 5200 Butler Parkway, Plymouth Meeting, Pennsylvania 19462, USA.
- American Hospital Association (AHA), 840 N, Lake Shore Drive, Chicago, Illinois 60611, USA.
- Food and Drug Administration (FDA), Center for Devices and Radiological Health, 1390 Piccard Drive, Rockville, Maryland 20850, USA.
- Canadian Medical Association, 1867 Alta Vista Drive, Ottawa, Ontario K1G 5W8, Canada.

1.5 Scope of the Book

Just like any other fields, health care is also subjected to human errors. In fact, each year in the United States, the death toll from human error in health care is higher than the combined death toll from breast cancer (42300) and motor vehicle accidents (43500).

More specifically, human error in health care is the eighth leading cause of deaths in the United States. A report entitled “To Err is Human” prepared by the Institute of Medicine (USA) in 1999 calls for greater attention on human errors in the medical field.

Over the years a large number of publications on human error in medicine have surfaced. Almost all of these publications are either journal or conference proceedings articles. There is no book that provides an up-to-date coverage of the subject. This book not only attempts to provide an up-to-date coverage of the on-going efforts on human error in medicine, but it also covers useful developments in the general areas of human reliability and human error. More specifically, the book covers the basics of human factors, human reliability, and human errors in addition to the useful techniques and models in these three areas. Moreover, a chapter on basic mathematical concepts was written to enable readers to better understand its contents as well as the calculations involved.

Finally, the basic objective of this book is to provide information related to human reliability and error to both health care and non-health care professionals. Such information can be useful in minimizing the occurrence of human error in health care. This book will serve as a guide to health care professionals, administrators, students, human factors specialists, biomedical and reliability engineers, as well as safety professionals.

Problems

1. Write an essay on human error in health care.
2. List any five important facts and figures related to human error in the medical field.
3. What is the most important factor, in your opinion, for the increasing attention on human error in health care?
4. What is the difference between human error and an adverse event?
5. Define the following terms:
 - Human reliability
 - Human error
 - Continuous task
6. What is the difference between risk and accident?
7. List at least five important journals for obtaining related information on human error in health care.
8. Define the following terms:
 - Human factors
 - Failure
 - Consequence

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