MEDICAL MISADVENTURE

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Introduction

It is not uncommon for the forensic pathologist to be involved in the investigation of the unexpected death of a hospitalized patient. In such cases, medical misadventure must be a serious consideration as a cause of death. In order to have the best chance at elucidating the cause of death, the forensic pathologist must have access to a thorough scene investigation and familiarity with the various types of medical misadventures that can cause death. Therapeutic misadventures can be broadly divided into (1) medication errors and (2) those involving mechanical devices.

Medication Errors

The Institute of Medicine (USA) in 2000 gave a lengthy and detailed report of the types of medication errors that can result in the death of a patient. It is estimated that medication errors cause at least one death every day in the USA. The ten most common

Table 1 Ten most common lethal medication errors in hospitalized patients

Concentrated potassium chloride injections
Insulin errors
Intravenous calcium and magnesium
Inadvertently administered 50% dextrose
Known allergy to medication
Miscalculated digoxin (pediatric patients)
Confusing vincristine and vinblastine (look-alike names)
Concentrated sodium chloride injections
Intravenous narcotics
Aminophylline

Data from Argo AL, Cox KF, Kelly WN (2000) The ten most common lethel medication errors in hospital patients. *Hospital Pharmacy* 35: 470–474.

lethal medication errors are listed in Table 1. While the most likely cause of the error associated with these medications is the administration of the wrong dose, other possibilities must be considered. For example, in one case the correct amount of potassium chloride concentrate was added to D5W (Dextrose 5% water) but the contents were not mixed well and the patient died due to hyperkalemia. In the case of calcium administration, care must be taken to clearly identify the salt form being used. Calcium gluconate contains $4.65\,\mathrm{mEq\,g^{-1}}$ of calcium, whereas calcium chloride contains $13.6\,\mathrm{mEq\,g^{-1}}$. Some institutions have stored these two forms next to each other leading to a mistake by the pharmacist or nurse. Poor penmanship on the part of the ordering physician can result in the wrong drug being dispensed and administered. This is exemplified by the death of a 42-year-old man who received 20 mg of Plendil rather than Isordil because the illegibility of the prescription caused the pharmacist to dispense the wrong medication. It is imperative that the patient record be examined for both what was ordered and what was given to a patient who dies unexpectedly. Similarly, abbreviations can result in lethal medication errors. Another reported source of error is confusing patients with similar names. It is not unusual for a harried caregiver to have two patients with the same surname and inadvertently administer the correct drug to the wrong patient. Because they have a direct impact on the central nervous system, intrathecal medications can be particularly dangerous. There have been several reports of death due to intrathecal vincristine administration. Recently, a 49-year-old woman was reported to have died following an overdose of intrathecal tranexaneic acid.

Of particular concern is the susceptibility of children to medication errors. Key factors include the size of the patient, the need to compute small dosages, and the fact that a ten-fold error may appear deceivingly normal to the person administering the drug. In addition to dosage errors, some medications initially thought to be safe for use on children have resulted in unexpected death, especially when used for other than the manufacturer's intended purpose. Newly approved drugs, although having passed Food and Drug Administration (FDA) testing, may result in death from side-effects undetected in the study population. Recent examples in adults include the weight reduction drug fen-fen. In pediatrics seemingly innocuous drugs can be catastrophic as in the vitamin E preparation eferol.

Another source of medical misadventure is laboratory testing. Perhaps the most common problem in this regard is patient or specimen misidentification. This in turn can lead to inappropriate and potentially life-threatening therapy. The area of greatest concern to the laboratory is the blood bank because administration of mismatched blood products can result in rapid death. The other main area of concern is electrolyte analysis. Errors in reporting abnormal values in potassium, calcium, or phosphorus can result in administration of these supplements and subsequently death.

Errors Involving Mechanical Devices

Medical care has been enhanced by an ever-increasing number of mechanical devices. Fortunately, most medical equipment has been thoroughly tested prior to approval for general use. Because of this, device failure is relatively rare. However, complications caused by user error or by device migration or displacement are a more common occurrence.

Endotracheal tubes and vascular catheters present the most frequent hazards. Respiratory arrest can result from displacement of endotracheal tubes and tracheostomy tubes. While these tubes are usually secured in place, patient movement may cause them to be dislodged. Furthermore, these tubes may be occluded by pulmonary secretions or other means. Resuscitation attempts are often thwarted by placement of the endotracheal tube in the esophagus. In 1986 Buchino and coworkers reported the unusual situation of two infants with tracheoesophageal fistula who died suddenly before surgery as the result of malpositioning of the endotracheal tube in the fistula.

Vascular catheters have also been a cause of medical misadventure and sudden death. We have seen unrecognized perforation of a large vessel during catheter insertion with subsequent hemorrhage into the abdominal or thoracic cavity causing exsanguination. Cardiac tamponade related to peripherally inserted central catheters has been reported. One review found 25 catheter-associated deaths over a five-year period reported from 83 newborn intensive care units. Pneumocardium has resulted from inadvertent injection of air into a central vascular catheter. In another instance, a 77-year-old woman, who received approximately

50 ml of enteral feed containing high-molecular-weight dextrin intravenously, died six hours later despite intensive emergency resuscitative attempts. Other tubing besides vascular catheters may be the source of error. Dramatic cases of inadvertent intracranial nasogastric tube placement have resulted in the death of patients. More recently, a fatal case of strangulation of an 11-month-old infant boy with intravenous tubing was reported.

A recent phenomenon has been patient deaths reported due to narcotic overinfusions resulting from the misprogramming of patient-controlled analgesic (PCA) infusion pumps. The incidents reported typically involve the entry of an erroneously low drug concentration when programming the pump for use, which causes the pump to deliver an excessive amount of the drug. Another cause for infusion pump error may be cellular technology. Hahn and coworkers reported the delivery of a toxic dose of adrenaline (epinephrine) because the rate setting of the intravenous pump was greatly accelerated by a nearby cell phone in the standby mode.

Investigation of Medical Misadventures

Adequate investigation of the death of a hospitalized patient due to suspected medical misadventure requires cooperation and coordination of hospital personnel, law enforcement officials, and forensic pathologists. A protocol, such as the example given in Table 2, is best followed to insure the highest yield of results. We suggest that forensic pathologists work with local law enforcement and hospital officials to proactively institute standard operating procedures in the event of a sudden, unexpected death of a hospitalized patient.

Following an unexpected death of a hospitalized patient, hospital personnel should secure the scene. This can be difficult because relatives and friends of the decedent may want to view the body. However, it should be explained to them that the best opportunity to determine the cause of death is to allow a rapid investigation to take place without disturbance of the environment of the deceased. Similarly, hospital personnel will typically attempt to clean the room following a failed resuscitation. However, in the process, valuable clues and trace evidence may be discarded.

Most states require notification of the coroner or other legal authority in the case of any unexpected death, regardless of the length of hospital stay. Hospital personnel should be instructed that as a general rule it is always better to err on the side of notifying these officials and letting them have the opportunity to decide whether or not they wish to investigate the situation further.

While not essential to the investigation, most hospitals would prefer to have a representative from their risk management department present during the procedure. Involving risk management personnel from the outset usually helps facilitate cooperation between the hospital and law enforcement.

All medical devices such as monitors and intravenous pumps that were used in the patient's care should be secured. They should not be disconnected from their power supply until examined by biomedical engineers to determine whether or not memory loss will occur if disconnected.

All premortem specimens should be saved by the laboratory for possible analysis. Likewise, all intravenous fluids attached to the patient should be analyzed. Fluids contained in syringes discarded in the sharps container in the patient's room should also be analyzed.

Although a sudden, unexpected death of a patient is traumatic for caregivers, it is important that they be interviewed concerning the events surrounding the death. Experience has shown that the most accurate information obtained is in the period immediately after the death.

Security cameras are now commonly used to monitor many areas within hospitals. Therefore, videotape of the events leading up to the death may be available. The security department should be notified to save any such tape of the area pending review by the investigating authorities.

Given the information generated from the scene investigation and the results of a complete autopsy to rule out natural causes of death, the forensic pathologist is then in the best position to determine if a medical misadventure played a role in the cause of death.

Table 2 Protocol template

Control and limit access to body and room; institute time log of persons entering room
Secure all items in room
Notify coroner and law enforcement
Notify risk management personnel
Notify laboratory to retain all biologic samples pertaining to patient
Notify security to retain monitor videos
Perform complete forensic autopsy

Modified from Buchino JJ, Corey TS, Montgomery V (2002) Sudden unexpected death in hospitalized children. *Journal of Pediatrics* 140: 461–465. © 2002. With permission from Mosby.

Further Reading

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