**Preventing Adverse Outcomes in Maintenance Hemodialysis Patients**
**Dr. Matthew Arduino, CDC**
**A Webber Training Teleclass**

## Preventing Adverse Outcomes In Maintenance Hemodialysis Patients

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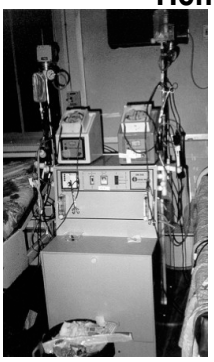
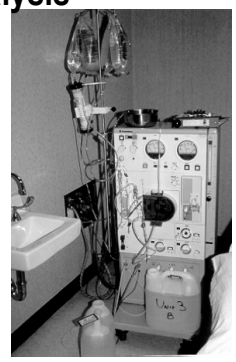
*The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention*

## Adverse Outcomes in ESRD

- Insufficient treatment
- Dialysis-Associated Infections
- Intoxications/Chemical Poisoning
  - Water treatment failures
  - System design
  - Human error
  - Manufacturing error
- Allergic Reactions
- Non-chemical associated hemolytic events
- Bleeding

## Hemodialysis





## I. Intoxications/Chemical Poisonings

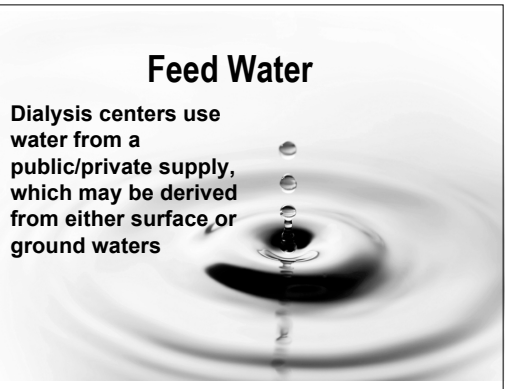
- **Failure to rinse germicide from dialyzers or hemodialysis system**
- **Water Treatment Issues**
  - **Trace elements in water**
  - **Malfunction of water treatment device**
  - **Biologic Toxins in water supply**
- **Dialysate Quality**
  - **Use of acid concentrate instead of acetate concentrate**

## Hemodialysis

- Hemodialysis patients are exposed to approximately 300-600 Liters of water/week.
- On average approximately 16-24 L of water is ingested per week.

## Feed Water

- **Dialysis centers use water from a public/private supply, which may be derived from either surface or ground waters**



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## Water Contaminants

- Biological: Water bacteria, endotoxin, cyanobacteria toxins (anatoxin-A, microcystin-LR)
- Chemical/Trace Elements: aluminum, arsenic, barium, cadmium, calcium, chlorine, chloramine, chromium, copper, fluoride, lead, magnesium, mercury, nitrate, potassium, selenium, silver, sodium, sulfate, strontium, zinc
- Chemical Contaminants Associated With Dialysis Outbreaks: Aluminum,Chlorine/Chloramine, Calcium and Magnesium, Copper, Strontium

## Clinical Effects of Contaminated Water

| Symptoms | Chemical Contaminant |
|---|---|
| Anemia | Aluminum, Chloramines, Copper, Zinc |
| Bone Disease | Aluminum, Fluoride, Strontium |
| Hemolysis | Chlorine/Chloramines, Copper, Nitrates |
| Hypertension | Calcium, Sodium |
| Hypotension | Bacteria, Endotoxin, Nitrates |

## Clinical Effects of Contaminated Water

| Symptoms | Chemical Contaminant |
|---|---|
| Metabolic Acidosis | Low pH, sulfates |
| Muscle Weakness | Calcium, Magnesium |
| Neurological Deterioration and Encephalopathy | Aluminum |
| Nausea and Vomiting | Bacteria, Calcium, Copper, Endotoxin, low pH, Magnesium, Nitrates, Sulphates, Zinc |

## Water Contaminants And The Lowest Level Concentration Associated With Toxicity In Hemodialysis Patients

| Contaminant | mg/L |
|---|---|
| Aluminum | 0.06 |
| Chloramines | 0.25 |
| Fluoride | 1.0 |
| Copper | 0.49 |
| Zinc | 0.2 |
| Nitrate (as N) | 21 |
| Sulfate | 200 |
| Calcium/Magnesium | 88 ($Ca^{2+}$) |
| Sodium | 300 |

## Aluminum Intoxications -Anemia, Bone Diseases, and Dementia

| Year | Outbreak Description | Cause | Corrective Action |
|---|---|---|---|
| **1982** | **Aluminum intoxication in 27 patients** | **Exhausted DI tanks** | **Install Reverse Osmosis and monitor DI tanks** |
| **1992** | **Aluminum intoxication in 27 patients; 3 deaths** | **Aluminum containing transfer pump (Acid Concentrate)** | **Discontinue pump use and substitute for a non aluminum containing pump** |
| **2007** | **Elevated serum aluminum levels in 10 patients (16–237 µg/L; median: 92)** | **Aluminum containing transfer pump (Acid Concentrate)** | **Discontinue pump use and substitute for a non aluminum containing pump** |

FDA SAFETY ALERT:
Aluminum and Other Trace Element Contamination in Dialysis Facilities

May 20, 1992

TO: HEMODIALYSIS PERSONNEL
WATER OR DIALSATE SERVICE CONTRACTORS

This is to alert you to a potentially hazardous situation in which dialysis patients have been exposed to dialysate with excessive aluminum levels. These high levels were leached over time from components of the dialysate delivery system. Other trace elements (e.g., iron, copper) could also leach out and contaminate the dialysate in certain circumstances. **Please share this Alert with those in your organization who are responsible for water treatment, dialysate delivery system and patient care.**

In a recent incident at a large suburban dialysis facility, investigated by the Food and Drug Administration and the Center for Disease Control (CDC), a large number of patients were found to have elevated serum aluminum levels. **Three patient deaths** were associated with aluminum toxicity.

Preliminary findings indicate that the acidified portion of bicarbonate-based dialysate solution was stored and/or metered to the dialysis patients' proportioning hemodialysis system through an aluminum-containing pump. Aluminum from the pump had leached unexpectedly into the dialysate concentrate during transfer to the patient.

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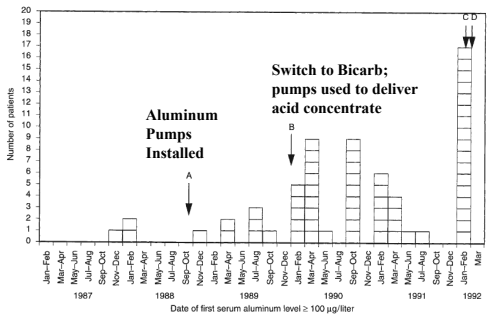


**Burwin D, et al. Epidemic aluminum intoxication in hemodialysis patients traced to use of an aluminum pump. *KI* 1995;48:469-474.**
**http://www.nature.com/ki/journal/v48/n2/abs/ki1995315a.html**

*Kidney International, Vol. 59 (2001), pp. 746–753*

Acute aluminum encephalopathy in a dialysis center caused by a cement mortar water distribution pipe

KENRICK BEREND, GISBERT VAN DER VOET, and WALTHER H. BOER

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**Acute aluminum encephalopathy in a dialysis center caused by a cement mortar water distribution pipe.**

*Background.* In Curaçao, distilled seawater from the water plant was used without further purification for hemodialysis for several decades. A new distribution pipe supplying water to a dialysis center on the island was installed in May 1996. To protect it from corrosion, this pipe was lined on the inside with a cement mortar. Because of the aggressiveness of the distilled water, calcium and aluminum (Al) leached from the cement mortar into the water used to prepare dialysate. This caused a possible hard water syndrome and definite acute Al intoxication.

of liters of dialysate every week, and contaminants present in the water may diffuse across the dialysis membrane and cause intoxications. Therefore, guidelines for the composition of water used to generate dialysate are very strict [1, 2]. To reach this standard, most dialysis centers use more or less elaborate water purification systems, consisting of combinations of water softeners, activated carbon filters, deionizers, and reverse osmosis (RO) [3–6].

We report the combination of an acute aluminum (Al) intoxication and a possible hard water syndrome in a

**http://www.nature.com/ki/journal/v59/n2/full/4492079a.html**

## Aluminum Exposure, 2007

- **Aluminum intoxication since 1992 is rare and sporadic**
- **Most aluminum exposure is from ingestion**
- **Other sources of Aluminum include some granular activated carbons**

## Aluminum Monitoring in Dialysis patients

- **National Kidney Foundation Disease Outcome Quality Initiative (K-DOQI) guidelines recommend serum aluminum testing at least annually in all dialysis patients, and every 3 months in those who receive aluminum-containing medications**
  - Cluster in 2007 was detected because of monthly serum aluminum levels
  - routine monitoring of serum aluminum levels can provide a useful tool in preventing serious illness among dialysis patients.

**http://www.kidney.org/professionals/KDOQI/guidelines_pedbone/guide14.htm**

## Fluoride Intoxications, Among US Hemodialysis patients

| Year | Description | Cause | Corrective Measures |
|---|---|---|---|
| **1980** | **Fluoride Intoxication in 8 patients, 1 death** | **Excess fluoride in city water; no water treatment by the dialysis facility** | **Install pretreatment and Reverse Osmosis unit** |
| **1993** | **Fluoride Intoxication in 9 patients, 3 deaths** | **Temporary DI water treatment system** | **DI tanks should be monitored by temperature compensate resistivity meters with both audible and visual alarms** |

## Symptoms of Acute Fluoride Intoxication

- Pruritis
- burning or feverish feeling
- Headache
- nausea or vomiting; or diarrhea
- syncope or near syncope
- pain in the chest, back, or abdomen

**FDA SAFETY ALERT:**
FLUORIDE CONTAMINATION OF HEMODIALYSIS WATER SUPPLY

TO: Hemodialysis Personnel and Water or Dialysate Service Contractors — August 19. 1993

This is to alert you to a recent incident in which three hemodialysis patients died and several others were hospitalized after exposure to high levels of fluoride in their dialysate, and to urge that you take certain precautions to prevent other incidents of this kind. Please share this Safety Alert with those within your organization who are responsible for water treatment, dialysate delivery systems (including water treatment systems), and patient care.

In the incident, which was investigated by the Food and Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC), the fluoride concentration in the dialysate was reported to be 15-25 ppm; the ANSI/AAMI standard identifies 0.2 ppm as the acceptable level of fluoride in dialysate.

The high concentrations occurred because the deionizer used to remove fluoride and other contaminants had become exhausted. Part of the problem may have been the warning lights on the deionizer tanks which are used to alert personnel that the deionizer is exhausted. The previous model at the facility used a single light to indicate that the system was functioning properly; when the light went out, the system was nearing exhaustion and needed replacement or regenerating.

## Toxigenic Cyanobacteria, Brazil 1996

- **Toxins include hepatotoxins and neurotoxins**
  - **Microcystin-LR**
  - **Anatoxin A**
- **Only known dialysis exposure was in Caruaru, Brazil**
  - **Center received untreated water; water was treated in center with carbon adsorption and DI**
  - **116/130 patients had visual disturbances, nausea and vomiting, and liver failure; at least 50 patients had died**
- **If water was treated using reverse osmosis toxins would have been removed**

**Jochimsen EM, et at. Liver Failure and Death after Exposure to Microcystins at a Hemodialysis Center in Brazil. *NEJM* 1998;338 (13):873-8 http://content.nejm.org/cgi/content/abstract/338/13/873**

## Human Error and Chemical Intoxications

**Patient exposure to disinfectants:**

- **Antimicrobial preservatives in filters**
  - **Sodium azide packed ultrafilters**
- **Water treatment system disinfectants**
  - **Formaldehyde**
  - **Hydrogen peroxide**
- **Resizing water distribution system for increased flow without taking into account pre-treatment needs**
  - **Monochloramine exposure**
- **Failure to adequately rinse disinfectant from Reprocessed dialyzers**
  - **Peracetic acid**
  - **Formaldehyde**

## Sodium Azide Exposure

- Temporary water treatment system including DI and ultrafilters.
- New industrial ultrafilters installed (not labeled for medical use)
  - Ultrafilters packed in 0.25% sodium azide and 25% glycerin to prevent bacterial contamination
- Severe life threatening hypotension in 9 patients, other symptoms included blurred vision, severe abdominal pain, headache, and loss of consciousness

**Gordon SM, et al. Epidemic hypotension in a dialysis center caused by sodium azide. *KI* 1990; 37:110–115 http://www.nature.com/ki/journal/v37/n1/pdf/ki199015a.pdf**

## Volatile Sulfur Compounds August 30, 2000

- 16 patients developed chills in the absence of fever and hypotension
- Odor ($H_2S$) in the unit detected
- Other symptoms: nausea, vomiting
- All were hospitalized
- One died within hours

## Toxic Effects of Sulfur Containing Compounds

- Toxic effects resulting from inhalation, ingestion or dermal exposure
  - Gastrointestinal
  - Respiratory
  - Central Nervous System
  - Skin
- NO documented parenteral exposures in humans

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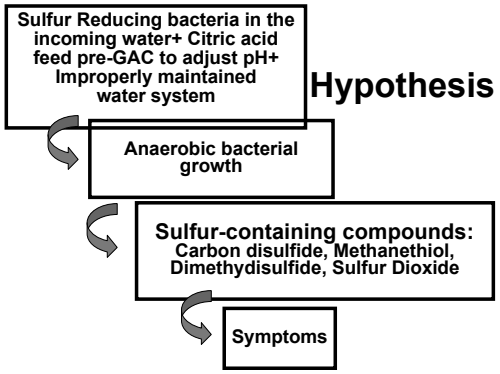


## Volatile Sulfur Compounds Summary

- Outbreak of severe and fatal reactions in hemodialysis patients
- Dialysis water contaminated with sulfur-containing compounds
- Recommendations:
  - Use pH controller and muriatic acid instead of citric acid
  - Prompt correction of reverse osmosis unit malfunction
  - Routine monthly disinfection of the water system

## Manufacturing Errors

- Occluded Bloodlines: Acute Hemolysis
- Althin Dialyzers Contaminated with Perfluorocarbon performance fluid

## Faulty Blood Tubing sets

*Kidney International, Vol. 57 (2000), pp. 1668-1674*

Multistate outbreak of hemolysis in hemodialysis patients traced to faulty blood tubing sets

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*Hospital Infections Program and National Center for Infectious Diseases, and International Emergency and Refugee Health Program, National Center for Environmental Health, Public Health Service, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Atlanta, Georgia; Office of Regulatory Affairs, Food and Drug Administration, Omaha, and Dialysis Center of Lincoln, Lincoln, Nebraska; Maryland Department of Health and Mental Hygiene, Baltimore, Maryland; Nebraska Health and Human Services System, Lincoln, Nebraska; Lahey Clinic, Burlington, Massachusetts; and Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, Georgia, USA*

**Multistate outbreak of hemolysis in hemodialysis patients traced to faulty blood tubing sets.**

*Background.* Hemolysis associated with hemodialysis is rare. The most frequent causes of hemodialysis-associated hemolysis are chemical contamination, heat or mechanical injury

iments with the hemodialysis blood tubing revealed that hemolysis was caused by increased pressure on erythrocytes as they passed through the partially occluded hemodialysis blood tubing.

*Conclusions.* Our investigation traced the multiple hemoly-

**http://www.nature.com/ki/journal/v57/n4/full/4491507a.html**

## Partially Occluded Blood Lines

- Patients in three states developed hemolysis while produced by a single manufacturer.
- 35 case patients
- 2 implicated tubing sets of lot 04D15309
- Gambro Healthcare estimated that the degree of occlusion in the defective cassette and tubing varied between 20 and 80%.
- The 300 defective cartridges went to the production of Cobe Centrysystem 3 blood tubing sets of lot numbers 04D15309, 04D15308, and 04D15310.
- Lots were recalled

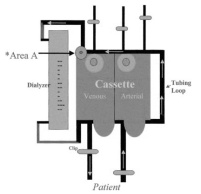


**Fig. 1. Schematic diagram of hemodialysis cassette and blood tubing set.** The connectors, cassette, clips and tubing can be seen. Color reproduction was made possible by the Centers for Disease Control and Prevention, Atlanta, GA, USA.

## Baxter/Althin Hemodialyzers

- In 2001, Baxter announced a voluntary recall of its AX, AF, and A series dialyzers following reports worldwide associated with the use of these dialyzers.
- The models of dialyzers recalled, labeled either Baxter or Althane are: Series A11, A15, A18, A22; Series AF150, AF180, AF220; and Series AX1500, AX2200
- Patients did not respond to any resuscitation efforts

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## Baxter/Althin Hemodialyzers

- The total death count as a result of the use of Baxter's affected dialyzers globally is over 50 hemodialysis patients. Spain, which had the first cases reported, had a total of 12 deaths.
- Highest mortality occurred in Croatia, which had 23 deaths.
- Four deaths occurred in the U.S. with two in Austin, TX, and two in Kearney, NE.
- Deaths also occurred in Colombia, Italy, Germany, and Taiwan

## Perfluorocarbon Performace fluid

- PF5070, perfluorocarbons play a prominent role in the process known as "dialysis repair" and has been used throughout the dialysis industry for more than 30 years without a problem
- To repair fibers in the manufacturing process that fail the initial leak test. PF5070 is then allowed to evaporate out of the dialyzer
- PF5070 Characteristics:
  - liquid at room temperature
  - a gas at body temperature
  - insoluble in plasma

**For additional information See:**
**http://biomed.brown.edu/Courses/BI108/BI108_2007_Groups/group05/pages/baxter.html**

## PF5070 Exposure

- Cardiac arrest
- Repsiratory Failure
- Severe hypotension, loss of consciousness
- Dyspnea
- Chest pain/Abdominal pain
- Nausea and vomiting

**Gasparovic V, Ostojic R.** ***Unexpected hemodialysis-related deaths in Croatia. J NEPHROL*** **2002; 15: 194-197**
**http://www.sin-italy.org/vecchiosito/jnonline/Vol15N2/194.html**

## Allergic Reactions

- May or may not occur in clusters
- Usually patients are easily identified and respond to changes in therapy, ie different reuse chemicals, different dialyzer membrane, preprocessing of hemodialyzers before use, benadryl

## ACE Inhibitors and Reuse

*Kidney International, Vol. 42 (1992), pp. 1232–1237*

Anaphylactoid reactions associated with reuse of hollow-fiber hemodialyzers and ACE inhibitors

DAVID A. PEGUES, CONSUELO M. BECK-SAGUE, STAN W. WOOLLEN, BONNIE GREENSPAN, SUSAN M. BURNS, LEE A. BLAND, MATTHEW J. ARDUINO, MARTIN S. FAVERO, ROBERT C. MACKOW, and WILLIAM R. JARVIS

*Hospital Infections Program, National Center for Infectious Diseases, Centers for Disease Control, Public Health Service, U.S. Department of Health and Human Services, Atlanta, Georgia, and Food and Drug Administration, Public Health Service, U.S. Department of Health and Human Services, Fairfax, and Continental Dialysis of Springfield-Fairfax, Springfield, Virginia, USA*

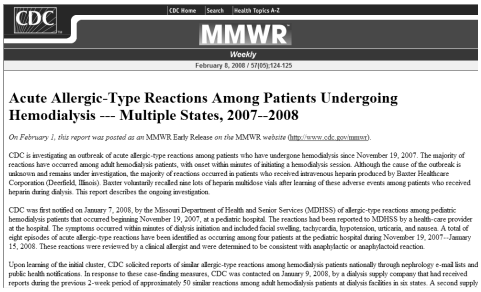
**Anaphylactoid reactions associated with reuse of hollow-fiber hemodialyzers and ACE inhibitors.** From July 18 through November 27, 1989, 12 anaphylactoid reactions (ARs) occurred in 10 patients at a hemodialysis center in Virginia. One patient required hospitalization; no patients died. ARs occurred within minutes of initiating dialysis and were characterized by peripheral numbness and tingling, laryngeal edema or angioedema, facial or generalized sensation of warmth, and/or nausea or vomiting. All 12 ARs occurred with dialyzers that had been reprocessed with an automated reprocessing system. A cohort study, including all patients undergoing dialysis sessions on the six days when an AR occurred, showed that the patients who experienced ARs were significantly more likely than patients who did not to be treated with angiotensin-converting enzyme (ACE) inhibitors (7/10 vs. 3/33; relative risk = 7.9; 95% confidence interval = 2.5 to 25.2) and to have been exposed to reused dialyzers rather than to new dialyzers (12/79 sessions vs. 0/31; $P = 0.016$). In those sessions using a reused dialyzer, the mean number of dialyzer uses in case-sessions was significantly higher than for noncase-sessions (10.3 vs. 6.2; $P = 0.016$). After reuse of dialyzers was discontinued at the center, no further ARs occurred, despite the sold; none of these reactions were associated with reused dialyzers [7].

In the United States, reuse of disposable hemodialyzers for the same patient is a common practice. From 1977 through 1989, the proportion of centers that reused dialyzers for the same patient increased from 18% to 68% [6]. The primary reasons for dialyzer reuse are the cost savings of reuse and avoidance of first-use syndrome. Reuse procedures are considered safe when standards of the Association for the Advancement of Medical Instrumentation are maintained [8, 9].

Reused dialyzers have been associated with outbreaks of infection with a variety of microorganisms and with an increased incidence of pyrogenic reaction compared with first-use dialyzers [6, 10–12]. In general, these outbreaks resulted from inadequate reprocessing procedures. However, outbreaks of

**http://www.nature.com/ki/journal/v42/n5/abs/ki1992409a.html**

## Contaminated Heparin



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MMWR

Weekly

February 8, 2008 / 57(05);124-125

**Acute Allergic-Type Reactions Among Patients Undergoing Hemodialysis --- Multiple States, 2007--2008**

*On February 1, this report was posted as an* MMWR Early Release *on the* MMWR *website* (http://www.cdc.gov/mmwr).

CDC is investigating an outbreak of acute allergic-type reactions among patients who have undergone hemodialysis since November 19, 2007. The majority of reactions have occurred among adult hemodialysis patients, with onset within minutes of initiating a hemodialysis session. Although the cause of the outbreak is unknown and remains under investigation, the majority of reactions occurred in patients who received intravenous heparin produced by Baxter Healthcare Corporation (Deerfield, Illinois). Baxter voluntarily recalled nine lots of heparin multidose vials after learning of these adverse events among patients who received heparin during dialysis. This report describes the ongoing investigation.

CDC was first notified on January 7, 2008, by the Missouri Department of Health and Senior Services (MDHSS) of allergic-type reactions among pediatric hemodialysis patients that occurred beginning November 19, 2007, at a pediatric hospital. The reactions had been reported to MDHSS by a health-care provider at the hospital. The symptoms occurred within minutes of dialysis initiation and included facial swelling, tachycardia, hypotension, urticaria, and nausea. A total of eight episodes of acute allergic-type reactions have been identified as occurring among four patients at the pediatric hospital during November 19, 2007--January 15, 2008. These reactions were reviewed by a clinical allergist and were determined to be consistent with anaphylactic or anaphylactoid reaction.

Upon learning of the initial cluster, CDC solicited reports of similar allergic-type reactions among hemodialysis patients nationally through nephrology e-mail lists and public health notifications. In response to these case-finding measures, CDC was contacted on January 9, 2008, by a dialysis supply company that had received reports during the previous 2-week period of approximately 50 similar reactions among adult hemodialysis patients at dialysis facilities in six states. A second supply

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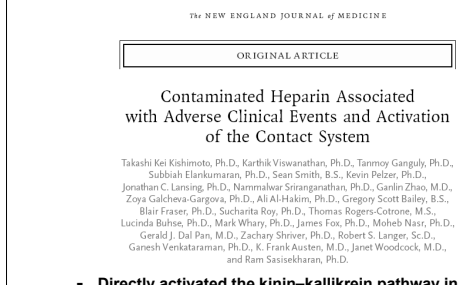
## Heparin Related Symptoms

- confirmed case episode of anaphylactic or anaphylactoid reaction characterized by angioedema (particularly swelling of lips/mouth, tongue, throat, or eyelids) or urticaria.
- A probable case had at least two of the following signs and symptoms:
  - generalized or localized sensations of warmth
  - numbness or tingling of the extremities
  - difficulty swallowing
  - shortness of breath, audible wheezing, or chest tightness
  - low blood pressure/tachycardia
  - nausea or vomiting.

## Acute Allergic Reactions from Contaminated Heparin

- **Oversulfated chondroitin sulfate OSCS) identified as a contaminant**
- **Directly activates complement and kallikrein systems**
- **Contaminated heparin products have now been found in at least 10 countries**
- **May also stimulate cytokine production**
- **Products from multiple suppliers received contaminated active pharmaceutical ingredient (API)**
  - **Baxter Healthcare**
  - **BBRaun**
  - **Covidien**
  - **American Health Products**

**http://content.nejm.org/cgi/reprint/NEJMoa0803200v2.pdf**



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Contaminated Heparin Associated with Adverse Clinical Events and Activation of the Contact System

Takashi Kei Kishimoto, Ph.D., Karthik Viswanathan, Ph.D., Tanmoy Ganguly, Ph.D., Subbiah Elankumaran, Ph.D., Sean Smith, B.S., Kevin Pelzer, Ph.D., Jonathan C. Lansing, Ph.D., Nammalwar Sriranganathan, Ph.D., Ganlin Zhao, M.D., Zoya Galcheva-Gargova, Ph.D., Ali Al-Hakim, Ph.D., Gregory Scott Bailey, B.S., Blair Fraser, Ph.D., Sucharita Roy, Ph.D., Thomas Rogers-Cotrone, M.S., Lucinda Buhse, Ph.D., Mark Whary, Ph.D., James Fox, Ph.D., Moheb Nasr, Ph.D., Gerald J. Dal Pan, M.D., Zachary Shriver, Ph.D., Robert S. Langer, Sc.D., Ganesh Venkataraman, Ph.D., K. Frank Austen, M.D., Janet Woodcock, M.D., and Ram Sasisekharan, Ph.D.

- **Directly activated the kinin–kallikrein pathway in human plasma**
- **OSCS induced generation of C3a and C5a,**

## Non-chemical Associated Hemolysis

- Dialysate temperature ≥ 40°C
  - Tielemans CL, Herbaut CR, Geurts JO, Dratwa M. Hemolysis and consumption coagulopathy due to overheated dialysate. *Nephron* 1982;30(2):190-1.
  - Hecht B, Berkman P, Risch ME. Letter: Hemolysis from hot dialysate. *Ann Intern Med.* 1975 Dec;83(6):902-3.
  - Berkes SL, Kahn SI, Chazan JA, Garella S. Prolonged hemolysis from overheated dialysate. *Ann Intern Med.* 1975 Sep;83(3):363-4.
- Dialysis against distilled water
  - Pendergrast JM, Hladunewich MA, Richardson RM. Hemolysis due to inadvertent hemodialysis against distilled water: Perils of bedside dialysate preparation. *Crit Care Med* 2006;34(10):2666-73.
- Kinked Blood tubing

## Hemolytic Dialysis Events

- Sometimes rare/sporadic events
- Clusters usually represent exposure to chemical agent
  - Differentiate from all potential causes
    - Kinking of tubing sets (Make sure using correct tubing set for machine)
    - Needle burs
    - Monochoramine/chlorine exposure
    - Drug reaction

## Bleeding/Exsanguination Events

- Current CDC investigation to determine risk factors
  - Exsanguination Deaths among Dialysis Patients: District of Columbia, Maryland, Virginia 1/2000 - 7/2007 (Ellingson K, Lucero C, Kurkjian K, Palekar R, Chai D, Schlossberg D)
  - Access failures
    - Fistulas, Grafts, catheters
  - Line separation

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## Motivation for Study

- Maryland Medical Examiner review of cases
  - Bleeding or "exsanguination" deaths in dialysis pts
  - 24 deaths over 6 years via retrospective review
  - Since 7/2006 13 additional cases noted by ME
- Little known about epidemiology
  - Cluster in Maryland?
  - Incidence in the US?
  - Case finding?
  - Preventable risk factors?

## CMS Data

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR MEDICARE & MEDICAID SERVICES

Form Approved
OMB No. 0938-0446

**ESRD DEATH NOTIFICATION**
**END STAGE RENAL DISEASE MEDICAL INFORMATION SYSTEM**

| | | |
|---|---|---|
| 1. Patient's Last Name | First / MI | 2. Medicare Claim Number |
| 3. Patient's Sex<br>a. ☐ Male b. ☐ Female | 4. Date of Birth<br>Month / Day / Year | 5. Social Security Number |
| 6. Patient's State of Residence | 7. Place of Death<br>a. ☐ Hospital c. ☐ Home e. ☐ Other<br>b. ☐ Dialysis Unit d. ☐ Nursing Home | 8. Date of Death<br>Month / Day / Year |
| 9. Modality at Time of Death<br>a. ☐ Incenter Hemodialysis b. ☐ Home Hemodialysis c. ☐ CAPD d. ☐ CCPD e. ☐ Transplant f. ☐ Other | | |
| 10. Provider Name and Address (Street)<br>Provider Address (City/State) | | 11. Provider Number |

- Providers must submit to CMS within 45 days
- Can select up to 5 causes of death
  - "39" Hemorrhage from Vascular Access
  - "40" Hemorrhage of Dialysis Circuit

## Analysis of CMS Data

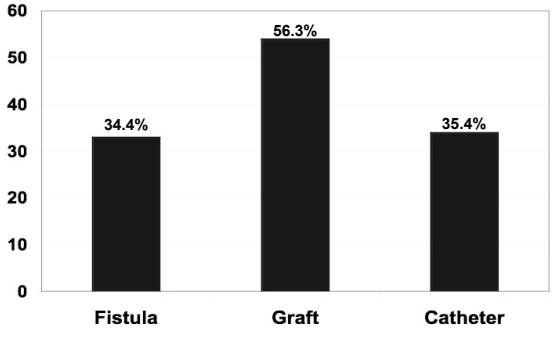
- CMS provided CDC with COD data for 2000-07
- Hemorrhage from Vascular access (HVA) and hemorrhage of dialysis circuit (HDC) accounted for **3.7/1000** ESRD deaths with known causes
  - **5.7/1000** ESRD deaths in MD (6th in US)
  - **6.5/1000** ESRD deaths in DC (2nd in US)
  - **5.4/1000** ESRD deaths in VA (7th in US)
    - ***1700+ deaths nationwide HVA/HDC codes***
    - ***18% ESRD deaths listed not coded or unknown***

## Proportional Death from HVA/HDC Top 10 States


## Case Description (N=96)

| | | N (%)<br>Median (range) |
|---|---|---|
| Sex | Female | 47 (49.0%) |
| | Age | 64 (28-92) |
| Race | Black | 68 (72%) |
| | White | 24 (25.3%) |
| | Other | 3 (3.2%) |

## Vascular Access Type (N=96)

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## Bleeding and Access Complications (N=73)

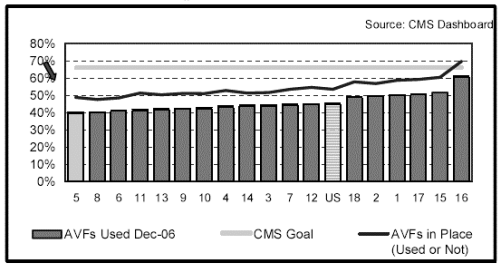
- 20.5% had documented history of a serious vascular access hemorrhage
- 72.6% had documentation of ANY access-related complications within the past 6 months
  - 30.1% Clotting
  - 27.4% Prolonged bleeding after dialysis
  - 20.6% Stenosis
  - 16.4% Superficial infection at access site
  - 13.7% Extensive vascular access infection
  - 11.0% Aneurysm or pseudoaneurysm
  - 4.1% Graft erosion

## Summary of Prototypes

- History of access-related problems/concerns
  - E.g. Infection, prolonged bleeding, erosions, aneurysms, clotting, repairs/revisions
- Anticoagulation-related events
  - Dialysis heparinization, systemic anticoagulation
- Psychosocial concerns
  - Depression, mental conditions, financial concerns, substance use, non-compliance
- Medical errors
  - CVC insertion events, needle dislodgements

## Regional Progress on Fistula First

Figure 6 PERCENT OF PREVALENT PATIENTS WITH AV FISTULAS Network 5 Compared to the U.S. - December 2006




## Preventing Adverse Events

- Follow standards and recommended practices
- Facility and System Designs
- Quality Assurance Performance Improvement (QAPI)
  - Surveillance Systems
  - Data Analysis
  - Inventory Control
- Documentation
- Know when to ask for help

## Water Treatment Systems

## AAMI Standards and Recommended Practices

- **RD62: Water treatment equipment for hemodialysis applications. ANSI/AAMI RD62-2006.**
- **Aimed at manufacturer's**
- **RD52: Recommended Practice-Dialysate for hemodialysis. ANSI/AAMI RD52-2004/A1-2007/A2/2007**
  - **Amendment 1- Annex C: Special considerations for home hemodialysis**
  - **Amendment 2 - Annex D: Self-assessment of compliance with recommendations for dialysate preparation**

## Water for Hemodialysis Applications

- **Defined Chemical agents**
  - **Group I: Agents known to cause adverse effects in patients**
  - **Group II: Agents known to be toxic for humans when present in potable water**
  - **Group III: Chemicals not normally harmful and are present in physiologic fluids and potentially dangerous if present in abnormal concentrations**
- **Defined levels for microbial contamination**

## Group 1 Maximum Allowable Chemical Contaminants Water for Hemodialysis Applications

| Chemical Agent | mg/L |
|---|---|
| Aluminum | 0.01 |
| Chlorine (free) | 0.50 |
| Chloramine | 0.10 |
| Copper | 0.10 |
| Fluoride | 0.20 |
| Nitrate | 2.00 |
| Sulfate | 100.00 |
| Zinc | 0.10 |

## Group II Chemical Contaminant Levels Water for Hemodialysis Applications

| Trace Element | mg/L |
|---|---|
| **Antimony** | **0.006** |
| **Arsenic** | **0.005** |
| **Barium** | **0.10** |
| **Beryllium** | **0.0004** |
| **Cadmium** | **0.001** |
| **Lead** | **0.005** |
| **Mercury** | **0.0002** |
| **Silver** | **0.005** |
| **Thallium** | **0.002** |
| **Chromium*** | **0.014** |
| **Selenium** | **0.09** |

*** Based on the "no-transfer" level**

## Group III Chemicals: Water for Hemodialysis Applications

| Chemical | mg/L | mEq/L |
|---|---|---|
| **Calcium** | **2** | **0.1** |
| **Magnesium** | **4** | **0.3** |
| **Sodium** | **70** | **3** |
| **Potassium** | **8** | **0.2** |

## Surveillance

- **On-line monitoring of water quality**
  - **Test for chlorine/chloramine prior to each patient shift**
  - **Test for hardness twice a day**
  - **On-line monitoring of TDS/Resistivity with temperature compensated meters (audio and visual alarms)**
- **Routine Environmental Cultures of Hemodialysis Fluids (monthly)**
- **At least annual chemical testing of water (preferrably with change of seasons)**
- **Patient Monitoring**
  - **Pyrogenic reactions and/or bacteremia**
  - **Other adverse patient reactions during dialysis**

## Surveillance System

- Documentation
  - Do you track lot numbers (drugs administered, dialysate concentrate, blood tubing sets, dialyzers, etc)
- Separate Log
  - Blood stream infections
  - Hepatitis sero-conversions
  - Adverse events (note symptoms and circumstances)

## Understanding a Voluntary Recall

- FDA can encourage the firm to voluntarily correct the problem or to recall a faulty product from the market.

## Email Listservers

- Nephrol
- Renalpro

To subscribe to Nephrol, RenalPro or other nephrology listserve see **http://www.cybernephrology.org/communication/commProviders.htm**

- DHQP Rapid Notification for Healthcare Professionals
- **http://www2a.cdc.gov/ncidod/hip/rns/hip_rns_subscribe.html**
- Free MMWR Subscription:
- http://www.cdc.gov/mmwr/mmwrsubscribe.html

## Additional On-line Resources

**CDC Dialysis Pages: www.cdc.gov/ncidod/dhqp/dpac.html**

**FDA Medwatch and E-listserv: www.fda.gov/medwatch**

**National Kidney Foundation-Kidney Dialysis Outcomes Quality Initiative (K-DOQI): www.kidney.org/professionals/KDOQI**

**Kidney Disease: Improving Global Outcomes (KDIGO): www.kdigo.org**

**United States Renal DataSystems: www.usrds.org**

**Fistula First: www.fistulafirst.org**

## The Next Few Teleclasses

| | |
|---|---|
| 22 May 08 | Bedpan Decontamination - Manual vs. Machanical<br>Speaker: Gertie van Knippengerg Gordebeke, International Consultant Infection Prevention and Hygiene, The Netherlands |
| 19 Jun. 08 | Environmental Sampling - Methods and Strategies<br>Speaker: Dr. Lynne Sehulster, CDC |
| 25 Jun. 08 | (South Pacific Teleclass) Peripheral Line Sepsis<br>Speaker: Dr. Steve McBride, Aukland District Health Board |
| 26 Jun. 08 | CBIC Teleclass 3 - The CIC Examination Process: Computer Based Testing<br>Speaker: CBIC Board Members & Guests |
| 17 Jul. 08 | (Free Teleclass) Community-Associated MRSA - What's Up & What's Next<br>Speaker: Dr. Rachel Gorwitz, CDC |
| 22 Jul. 08 | (Free British Teleclass) Progress Report from the Chief Nursing Officer<br>Speaker: Christine Beasley, British Department of Health |
| 24 Jul. 08 | (Free Teleclass) Disinfection & Sterilization - Current Issues & New Research<br>Speaker: Dr. William Rutala, University of North Carolina |

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