

- Productivity in Health Services Conference Proceedings*. Norcross, GA: Institute of Industrial Engineers; 1996:143-150.
110. Benneyan JC. On the Application and Interpretation of Control Charts With Unequal Subgroup Sizes With Application to Hospital Length of Stay Data. Technical Report. University of Massachusetts: Industrial Engineering and Operations Research; 1996.
  111. Zimmerman SM, Brown LD, Brown SS, Alexander L. Human body function control charts for the physician. *ASQC Quality Congress Transactions* 1990:408-412.
  112. Garlock JH, Seley GP. The use of sulfanilamide in surgery on the colon and rectum. preliminary report. *Surgery* 1939;5:787-790.
  113. Classen DC, Evans RS, Pestotnik SL, Horn SD, Menlove RL, Burke JP. The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. *N Engl J Med* 1992;326:281-286.
  114. Wenzel RP. Preoperative prophylactic antibiotics: brief historical note. *Infect Control Hosp Epidemiol* 1993;14:121.
  115. Jackson JE. All count distributions are not alike. *Journal of Quality Technology* 1972;4(2):86-92.
  116. Johnson NL, Kotz S, Kemp AW. *Univariate Discrete Distributions*. 2nd ed. New York, NY: John Wiley and Sons, Inc; 1992.
  117. Mendenhall W, Scheaffer RL, Wackerly DD. *Mathematical Statistical with Applications*. 4th ed. Boston, MA: Duxbury Press; 1990.
  118. Devore JL. *Probability and Statistics for Engineering and the Sciences*. 2nd ed. Monterey, CA: Brooks/Cole Publishing Co; 1987.
  119. Guttman I, Wilks SS, Hunter JS. *Introductory Engineering Statistics*. 3rd ed. New York, NY: John Wiley and Sons, Inc; 1982.
  120. Benneyan JC. *Statistical Control Charts Based on Geometric and Negative Binomial Distributions*. University of Massachusetts, Amherst, MA; 1992. Thesis.
  121. Kaminsky FC, Benneyan JC, Davis RB, Burke RJ. Statistical control charts based on a geometric distribution. *Journal of Quality Technology* 1992;24(2):63-69.
  122. Newell DJ. Unusual frequency distributions. *Biometrics* 1965;21:159168.
  123. Brawley RL, Weber DJ, Samsa GP, Rutala WA. Multiple nosocomial infections, an incidence study. *Am J Epidemiol* 1989;130:769-780.
  124. Benneyan JC. An introduction to using statistical process control (SPC) within health care. *International Applied Statistics in Medicine Conference Transactions*. In press.
  125. Benneyan JC, Kaminsky FC. Successfully applying SPC to improve health care: pitfalls and barriers to improving quality and reducing liability. *Proceedings of the ASQC Annual Quality Congress Transactions*. Milwaukee, WI: American Society for Quality, Inc; 1995:578-586.
  126. Liu MC, Fernandez JE, Davis PJ. A statistical process control approach to carpal tunnel syndrome risk evaluation. *Quality Engineering* 1993;5:375-392.
  127. Alemi F, Rom W, Eisenstein E. Risk adjusted control charts for health-care assessment. *Annals of Operations Research* 1996;67:45-60.
  128. Sloan MD, ed. *Success Stories on Lowering Health Care Costs by Improving Health Care Quality*. Milwaukee, WI: ASQC Press; 1995.
  129. Wernimont G. Use of control charts in the analytic laboratory. *Ind Eng Chem Anal Ed* 1946;18:587-592.
  130. Levey S, Jennings ER. The use of control charts in clinical laboratories. *Am J Clin Pathol* 1950;20:1059-1066.
  131. Benneyan JC. Statistical Quality Control in Clinical Laboratories. Technical Report. University of Massachusetts: Industrial Engineering and Operations Research; 1995.
  132. Kaminsky FC, Benneyan JC, Andrzejewski C. Total Quality Management and Statistical Process Control in the Clinical Laboratory With Applications to EIA Testing for HIV-1/2 and Hepatitis Antibodies. Technical Report. Greenfield, MA: Productivity Sciences Inc; 1995.
  133. Gentleman RC, Hamada MS, Matthews DE, Wilson AR. Statistical quality control of HIV-1 ELISA test performance. *Journal of the American Statistical Association* 1994;89:1200-1208.
  134. Carey RG. *Measuring Quality: Report Cards Get Low Grades*. Parkridge, IL: Parkside Associates; 1995.
  135. O'Leary DS. Measurement and accountability: taking careful aim. *Jt Comm Journal on Quality Improvement* 1995;21:354-357.

## Control of *Legionella pneumophila* in Hospital Hot-Water Supply

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Heat treatment and application of copper-silver ionization often are used for controlling *Legionella pneumophila* in high-volume hospital plumbing systems. However, the comparative efficacies of these measures in high-volume systems are unknown.

Investigators from Children's Hospital of Pittsburgh have reported on studies that show differences in efficacy. Thermal treatment of a hot-water circuit was accomplished by flushing hot water (>60°C) through distal fixtures for 10 minutes. Copper-silver ionization was conducted in three circuits by installing units into

return lines immediately upstream from hot-water tanks. Recovery rates of *L pneumophila* were monitored by culturing swab samples from faucets. Concentrations of copper and silver in water samples were determined by atomic absorption spectrophotometry. Four heat-flush treatments failed to provide long-term control of *L pneumophila*. In contrast, ionization treatment reduced the rate of recovery of *L pneumophila* from 108 faucets from 72% to 2% within 1 month and maintained effective control for at least 22 months. Only three samples (1.9%) of hot water from faucets exceeded Environmental Protection Agency standards for silver, and none exceeded the standards for copper. Of 24 sam-

ples obtained from hot-water tanks, 42% and 50% exceeded the silver and copper standards, respectively.

The authors concluded that copper-silver ionization effectively controls *L pneumophila* in high-volume plumbing systems and is superior to thermal treatment. However, high concentrations of copper and silver can accumulate at the bottom of hot-water tanks.

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