

## Occupational Sentinel Health Events: An Up-Dated List for Physician Recognition and Public Health Surveillance

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An occupational sentinel health event (SHE[O]) is a disease, disability, or untimely death, which is occupationally related and whose occurrence may: 1) provide the impetus for epidemiologic or industrial hygiene studies; or 2) serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required. Following survey of scientific literature, a list of 50 disease conditions linked to the workplace was presented in 1983; these were codable within the framework of the International Classification of Diseases system (ICD-9). Three criteria were used for inclusion: documentation of associated agent(s), of involved industries, and of involved occupations. The up-dated list contains 64 diseases or conditions and a bibliography of literature citations. The list is useful for the practicing physician in occupational disease recognition, for occupational morbidity and mortality surveillance, and as a periodically up-dated database of occupationally related diseases.

**Key words:** occupational disease prevention, occupational disease surveillance, epidemiology, occupational mortality surveillance

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### INTRODUCTION

In 1976, the sentinel health event (SHE) was introduced by Rutstein et al., who conceived its use as a method for determining the quality of medical care. In essence, the approach is one of identifying negative indices of health care, i.e., those health events that signal the need for scrutiny of the quality of medical care:

The occurrence of an unnecessary disease, disability, or untimely death is a sentinel health event that justifies carefully controlled scientific search for remediable underlying causes [Rutstein et al., 1976].

This method had its genesis in the maternal mortality studies of the New York Academy of Medicine in the early 1930s in which each maternal death in New York

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Accepted for publication October 5, 1990.

City was carefully investigated and reviewed by a group of obstetricians. Careful application of the principles of the SHE led to a sharp decrease in maternal mortality in New York City.

In 1983, the SHE concept was modified for use in the field of occupational disease [Rutstein et al., 1983]. An occupational sentinel health event (SHE(O)) is defined as

“A disease, disability, or untimely death which is occupationally related and whose occurrence may: 1) provide the impetus for epidemiologic or industrial hygiene studies; or 2) serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required [Rutstein et al., 1983].”

The 1983 SHE(O) list encompassed 50 work-related conditions. These conditions were collated from reports in the scientific literature. Most of the reports were epidemiologic studies conducted in the workplace; a few were case reports. All diseases and conditions were codable within the framework of the Ninth Revision, International Classification of Diseases Adapted for Use in the United States, 1975 (ICD-9) [World Health Organization (WHO), 1977]. Two broad categories of SHE(O)s were represented. The first group included those diseases or conditions that, by their inherent nature, are occupationally related. Such conditions include the pneumoconioses; it is unlikely that these diseases would occur in the absence of an occupational exposure to the inciting agent. The second set of conditions included such diseases as lung cancer, leukemia, peripheral neuropathy, and ornithosis, which may or may not be occupationally related; further information on the industry and occupation is required to establish a causal link between disease condition and occupation.

As our knowledge base grows, the list of SHE(O)s is up-dated to include new disease conditions that are associated with occupation. This list may serve as a framework for occupational health surveillance at the state and local level. It may also be used as a guide for practicing physicians caring for patients when there is a question of occupational illness. The list is presented in tabular form and is up-dated periodically to accommodate new occupational disease conditions. Further reports will be disseminated as they are completed and reviewed. This is the first up-date of the 1983 list.

## **MATERIALS AND METHODS**

The 1983 SHE(O) list has been up-dated using the same methodology employed earlier. The occupational health literature was surveyed for articles that met three criteria of scientific proof: documentation of associated agent(s), of involved industries, and of involved occupations. In accordance with the previous methodology, only diseases and conditions codable within the framework of the ICD-9 or its clinical modification, the ICD-9-CM [WHO, 1986] were selected.

Studies were identified from the occupational health literature that would add to the 1983 list in any of four dimensions: 1) new ICD condition with involved occupation, industry, and etiologic agent, or 2) for disease conditions already present on the 1983 SHE(O) list, a) additional information on industry where the condition has been noted to occur, or b) additional information on occupation where the condition has been noted to occur, or c) new agents that may cause the condition.

For this up-date, the following additional criteria were considered. 1) A sound epidemiologic study with appropriate controls, endpoint, and specifics concerning occupation, industry, and agent was required. 2) For case reports, more than one case report identifying similar industry and occupation characteristics was required. 3) In the case of lung cancer, the study must have been controlled for smoking history. 4) For death certificate studies, there must have been confirmatory studies using more rigorous methodologies. Some studies that were equivocal are not included in the present table, but have been held for future review. In addition, some reports have been placed "on hold" until confirmed by more supportive studies. These include 1) studies in which results are only suggestive or preliminary, 2) a single death certificate study, 3) a single case report or a single report of cases in one workplace (i.e., a case series report), 4) a questionnaire study, or 5) studies using collapsed ICD codes for disease conditions.

The disease conditions in the original 1983 table were utilized as a start for this up-dated table. Literature searches were conducted on a specific condition to obtain new or up-dated occupations, industries, or agents that may cause the same disease condition. Recent NIOSH health hazard evaluations, NIOSH technical reports, or recent articles in occupational health journals provided additional leads for new conditions, occupations, industries, and agents. The data were mainly analyzed by the NIOSH authors; some new disease conditions were reviewed by experts in the field. The literature searches and analyses are being done almost continuously.

## RESULTS

A total of 314 articles from the occupational health literature were ultimately reviewed for consideration for inclusion in the up-dated SHE(O) list. Most of these were epidemiologic studies; some were case reports. Of these, 106 (33.8%) have been included in the up-dated list. An additional 85 (27%) articles, many of which are case reports, have been placed "on hold," pending confirmatory studies.

The up-dated SHE(O) list now contains 64 disease conditions. Eleven of these disease conditions are new inclusions to the list. Seven of the new disease condition inclusions belong to the infectious disease group (ICD term "Cutaneous Diseases due to Other Mycobacteria," i.e., "fish fancier's finger," herpetic whitlow, human immunodeficiency virus infection, Rocky Mountain spotted fever, leptospirosis, histoplasmosis, and sporotrichosis). None of these conditions is solely related to occupation. Other new disease conditions include malignant neoplasm of the nasopharynx, mononeuritis of the upper limb and mononeuritis multiplex (including carpal tunnel syndrome), unspecified allergic alveolitis, and skeletal fluorosis (modified from ICD code 733.9, Other Disorders of Bone and Cartilage). Under the rubric of unspecified allergic alveolitis, several conditions related to various agents and industries are included, e.g., cinnamon processing, paper manufacture, and snow crab processing. In addition, extrinsic allergic alveolitis has been resolved into its several constituent respiratory conditions compatible with the ICD coding: malt worker's lung, mushroom worker's lung, grain handler's lung, and sequoiosis.

The SHE(O) list is arranged in ascending order of the ICD codes. When further I/O information is needed to establish the relationship of disease to occupation (i.e., for those disease conditions that are not inherently occupational), an "O" has been affixed to the disease condition's name in the table (Table I). In addition to the disease

Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\*

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process/occupation	Agent
011	Pulmonary tuberculosis (O)	P <sup>d</sup>	P, T <sup>e</sup>	P, T	Physicians <sup>16</sup> , medical personnel <sup>208</sup> , medical lab workers <sup>106</sup> .	<i>Mycobacterium tuberculosis</i> . <sup>16,106,208</sup>
011, 502	Silicotuberculosis	P	P, T	P, T	Quarrymen, sandblasters, silica processors, mining, metal foundries, ceramic industry. <sup>33</sup>	Silica + <i>Mycobacterium tuberculosis</i> . <sup>33,121,227</sup>
020	Plague (O)	P	—	—	Shepherds, farmers, ranchers, hunters, field geologists. <sup>8</sup>	<i>Yersinia pestis</i> . <sup>8,224</sup>
021	Tularemia (O)	P	—	P, T	Hunters, fur handlers, sheep industry workers, <sup>129</sup> cooks, vets, ranchers, vet pathologists, <sup>246</sup> lab workers <sup>193</sup> , soldiers <sup>271</sup> .	<i>Francisella tularensis</i> , <sup>129,246</sup> <i>Pasteurella tularensis</i> . <sup>193,271</sup>
022	Anthrax (O)	P	—	P, T	Shepherds, farmers, butchers, handlers of imported hides or fibers, <sup>29</sup> vets, vet pathologists, weavers, <sup>172</sup> farmers <sup>204</sup> .	<i>Bacillus anthracis</i> . <sup>29,172,204,247</sup>
023	Brucellosis (O)	P	P	P	Farmers, shepherds, veterinarians, lab workers. <sup>189,279</sup> slaughterhouse workers <sup>172,247</sup> , field officers <sup>279</sup> .	<i>Brucella abortus, suis</i> . <sup>172,189,247,279</sup>
031.1 <sup>f</sup>	Fish-fancier's finger (O)	P	P	P	Aquarium worker/cleaner, breeder/owner. <sup>117,148,151,158,251</sup> Longshoremen <sup>278</sup> .	<i>Mycobacterium marinum</i> . <sup>117,148,151,158,251</sup> <i>Mycobacterium marinum</i> . <sup>278</sup>
054.6	Herpetic whitlow (O)	P	P	P	Surgical residents, student nurses, <sup>101</sup> nurses <sup>156,218</sup> , dental assistant <sup>171</sup> , physicians <sup>218</sup> , orthopedic scrub nurse, psychiatric nurse. <sup>231</sup>	Herpes simplex virus. <sup>101,156,171,218,231</sup>
037	Tetanus (O)	P	P	P	Farmers, ranchers. <sup>246</sup>	<i>Clostridium tetani</i> . <sup>246</sup>
042 <sup>g</sup>	Human immunodeficiency virus (O)	P	P	P	Health care workers. <sup>45,181</sup>	Human immunodeficiency virus. <sup>45,181</sup>
056	Rubella (O)	P	P	P	Medical personnel <sup>88,165,206</sup> , intensive care personnel <sup>208</sup> .	Rubella virus. <sup>88,165,206</sup>
070.0 .1	Hepatitis A (O)	P	P	P	Day care center staff <sup>99,249</sup> , orphanage staff <sup>εε39</sup> , mental retardation institution staff <sup>7108,239</sup> , medical personnel <sup>89</sup> .	Hepatitis A virus. <sup>39,89,99,108,239,249</sup>

(continued)

**Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\* (Continued)**

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process/occupation	Agent
070.2 .3	Hepatitis B (O)	P	P	P	Nurses and aides, <sup>76,102,137</sup> anesthesiologists <sup>40</sup> , orphanage and mental institution staff, <sup>76</sup> med lab personnel <sup>137,147,154</sup> , general dentists <sup>180</sup> , oral surgeons <sup>77</sup> , physi- cians <sup>102,137,147</sup> .	Hepatitis B virus. <sup>40,76,77,102,137,147,154</sup>
070.4	Non-A, non-B hepatitis (O)	P	P	P	As above for hepatitis A and B.	Unknown.
071	Rabies (O)	P	—	P	Veterinarians, animal and game wardens, lab researchers, farmers, ranchers, trappers. <sup>246</sup>	Rabies virus. <sup>246</sup>
073	Ornithosis (O)	P	—	P,T	Psittacine bird breeders, pet shop staff, poultry producers, vets, zoo employees, <sup>10,173</sup> duck processing and rearing. <sup>9,194</sup>	<i>Chlamydia psittaci</i> . <sup>9,10,173,194</sup>
082.0	Rocky Mountain spotted fever (O)	P	P	P,T	Laboratory tech- nicians <sup>37,130</sup> , tick breeder, virologist, microbiologist, <sup>130</sup> physician <sup>235</sup> .	<i>Rickettsia rickettsii</i> . <sup>37,130,235</sup>
100.8	Leptospirosis (O)	P	P	P,T	Farmer/laborer. <sup>70</sup>	<i>Leptospira</i> . <sup>70</sup>
115	Histoplasmosis (O)	P	P	P,T	Bridge maintenance workers <sup>244</sup> .	<i>Histoplasma capsulatum</i> . <sup>244</sup>
117.1	Sporotrichosis (O)	P	P	P	Nurserymen, foresters, florist, equipment operators. <sup>55,57,84,97,207</sup>	<i>Sporothrix schenkii</i> . <sup>55,57,84,97,207</sup>
147	Malignant neoplasm of nasopharynx (O)	P	P	P	Carpenter, cabinet maker, sawmill worker, lumberjack, electrician, fitter. <sup>103</sup>	Chlorophenols. <sup>103</sup>
155 M <sup>h,i</sup>	Hemangiosarcoma of the liver	P	P	P	Vinyl chloride polymerization industry <sup>54</sup> . Vintners <sup>75</sup> .	Vinyl chloride mono- mer. <sup>54,125,126,245,272</sup> Arsenical pesticides. <sup>75,125</sup>
158, 163	Mesothelioma (MN of peritoneum and pleura)	P	—	P	Asbestos industries and utilizers. <sup>21,143</sup>	Asbestos. <sup>21,121,125,143,232,233</sup>
160.0	Malignant neoplasm of nasal cavities (O)	P	P,T	P,T	Woodworkers, cabinet and furniture makers. <sup>3,5,34,155,221</sup> Boot and shoe industry, <sup>2,3</sup> Radium chemists and processors, <sup>74</sup> dial painters <sup>205</sup> .	Hardwood dusts. <sup>3,5,34,155,221</sup> Unknown. <sup>2,3</sup> Radium. <sup>74,205</sup>

(continued)

**Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\* (Continued)**

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process /occupation	Agent
					Chromium producers, processors, users. <sup>125</sup>	Chromates. <sup>125</sup>
					Nickel smelting and refining. <sup>65,124,259</sup>	Nickel. <sup>65,124,125,259</sup>
161	Malignant neoplasm of larynx (O)	P	P,T	P,T	Sawmill worker, carpenter. <sup>103</sup> Asbestos industries and utilizers. <sup>219</sup>	Chlorophenols. <sup>103</sup> Asbestos. <sup>125,219</sup>
162	Malignant neoplasm of trachea, bronchus, and lung (O)	P	P	P	Asbestos industry and utilizers. <sup>21,66,143</sup> Topside coke oven workers. <sup>152,211,212</sup> Uranium and fluorspar miners. <sup>50,62,91,222,275</sup> Chromium producers, processors, <sup>73</sup> users. <sup>159,252</sup> Nickel smelters, processors, users. <sup>65,124</sup> Smelters. <sup>113,257</sup> Mustard gas formulators. <sup>268</sup> Ion exchange resin makers, chemists. <sup>79,163,273,274</sup> Iron ore (underground) miners. <sup>68,69,142,210</sup> Plant protection workers/agronomists. <sup>17</sup> Welders. <sup>20</sup> Copper smelter and roaster workers. <sup>12,199,202,213,277</sup>  Welders, gas cutters. <sup>240</sup> Foundry—floor molders and casters. <sup>85,136,258</sup> Dichromate production—floor molders/casters. <sup>190</sup> Chromate production. <sup>1,260</sup> Chromate pigment production workers. <sup>59,81</sup> Pigment production. <sup>140</sup> Steel industry—furnace/foundry workers. <sup>25</sup> Rubber reclaim operations. <sup>60</sup> Radium chemists and processors, <sup>74</sup> dial painters. <sup>160</sup>	Asbestos. <sup>21,66,125,143,232</sup> Coke oven emissions. <sup>152,211,212</sup> Radon daughters. <sup>50,62,91,222,275</sup> Chromates. <sup>73,125,159,252</sup> Nickel. <sup>65,124,125</sup> Arsenic. <sup>125,257</sup> , arsenic trioxide. <sup>113</sup> Mustard gas. <sup>268</sup> Bis(chloromethyl) ether, chloromethyl methyl ether. <sup>79,125,163,273,274</sup> Radon daughters. <sup>68,69,142,210</sup> Pesticides, herbicides, fungicides, insecticides. <sup>17</sup> Unknown. <sup>20</sup> Inorganic arsenic. <sup>199,213,277</sup> , sulfur dioxide. <sup>12,213</sup> , copper. <sup>12,213</sup> , lead. <sup>213</sup> , sulfuric acid. <sup>213</sup> , arsenic trioxide. <sup>12,202</sup> Asbestos, hexavalent chromium. <sup>240</sup> Polyaromatic hydrocarbons. <sup>85</sup> Unknown. <sup>190</sup> Chromium dust. <sup>1,260</sup> Lead chromate, zinc chromate. <sup>59,81</sup> Zinc chromate dust. <sup>140</sup> Unknown. <sup>25</sup> Unknown. <sup>60</sup> Radium. <sup>74,160</sup>
170	Malignant neoplasm of bone (O)	P	—	P	Automatic lathe operators. <sup>109,132</sup> , metalworkers. <sup>220</sup>	Mineral/cutting oils. <sup>109,125,132</sup>
187.7	Malignant neoplasm of scrotum	P	—	P,T		

(continued)

Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\* (Continued)

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process /occupation	Agent
					Coke oven workers, petroleum refiners, tar distillers. <sup>109</sup>	Soots/tars/tar distillates. <sup>109,125</sup>
					Tool setters, fitters, cotton spinners, chimney sweeps, machine operators. <sup>270</sup>	Mineral oil, pitch, tar. <sup>270</sup>
188	Malignant neoplasm of bladder (O)	P	—	P	Rubber and dye workers. <sup>42,43,282</sup>	Benzidine <sup>230,282</sup> , alpha- and beta-naphthylamine, <sup>42,125</sup> magenta, auramine, <sup>43,125</sup> 4-aminobiphenyl <sup>169</sup> , 4-nitrophenyl. <sup>125,263</sup>
189	Malignant neoplasm of kidney, other, and unspecified urinary organs (O)	P	P	P	Coke oven workers <sup>211,212</sup> .	Coke oven emissions. <sup>211,212</sup>
204.0	Lymphoid leukemia (O)	P	—	P	Rubber industry <sup>166,167</sup> , Radiologists <sup>161,162</sup> .	Unknown. <sup>166,167</sup> Ionizing radiation. <sup>53,161,162</sup>
205.0	Myeloid leukemia, acute (O)	P	—	P	Occupations with exposure to benzene. <sup>7,122,123,125,265,266</sup> Radiologists <sup>161,162</sup> .	Benzene. <sup>7,122,123,125,265,266</sup> Ionizing radiation. <sup>53,161,162</sup>
207.0	Erythro-leukemia (O)	P	—	P	Occupations with exposure to benzene. <sup>7,122,123,125,265,266</sup>	Benzene. <sup>7,122,123,125,265,266</sup>
283.1	Hemolytic anemia, nonautoimmune (O)	P	—	P	Whitewashing and leather industry. <sup>61</sup> Electrolytic processes, arsenical ore smelting. <sup>116</sup> Plastics industry <sup>6</sup> . Dye, celluloid, resin industry. <sup>86</sup>	Copper sulfate. <sup>61</sup> Arsine. <sup>116,133,195,201</sup> Trimellitic anhydride. <sup>6</sup> Naphthalene. <sup>86</sup>
284.8	Aplastic anemia (O)	P	—	P	Explosives manufacture <sup>120,237</sup> . Occupations with exposure to benzene. <sup>7,265,266</sup> Radiologists <sup>162</sup> , radium chemists and dial painters. <sup>238</sup>	Trinitrotoluene. <sup>107,120,237</sup> Benzene. <sup>7,265,266</sup> Ionizing radiation. <sup>53,162,238</sup>
288.0	Agranulocytosis or neutropenia (O)	P	—	P	Occupations with exposure to benzene. <sup>7,265,266</sup> Explosives and pesticide industries. <sup>31</sup> Pesticides, pigments, pharmaceuticals. <sup>138</sup>	Benzene. <sup>7,265,266</sup> Phosphorus. <sup>31</sup> Inorganic arsenic. <sup>138</sup>
289.7	Methemoglobinemia (O)	P	—	P,T	Explosives and dye industries. <sup>100,107,182,281</sup> Rubber workers <sup>191</sup> .	Aromatic amino and nitro compounds (e.g., aniline, trinitrotoluene, nitroglycerin). <sup>100,107,120,182,281</sup> Aniline, o-toluidine, nitrobenzene. <sup>191</sup>
323.7	Toxic encephalitis (O)	P	P	P	Battery, smelter, and foundry workers. <sup>14,30</sup> Electrolytic chlorine production, battery makers, fungicide formulators. <sup>18,30</sup>	Lead. <sup>14,30</sup> Inorganic and organic mercury. <sup>18,30,78</sup>

(continued)

**Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\* (Continued)**

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process /occupation	Agent
332.1	Parkinson's disease (secondary) (O)	P	P	—	Manganese processing, battery makers, welders. <sup>225</sup> Internal combustion engine industries <sup>87</sup> .	Manganese. <sup>225,243</sup> Carbon monoxide. <sup>87</sup>
334.3	Cerebellar ataxia (O)	P	P	—	Chemical industry using toluene <sup>27</sup> . Electrolytic chlorine production, battery makers, fungicide formulators. <sup>30,56</sup>	Toluene. <sup>27</sup> Organic mercury. <sup>30,56</sup>
354M <sup>d</sup>	Carpal tunnel syndrome (O)	P	P	—	Meat packers, deboners. <sup>250</sup>	Cumulative trauma. <sup>250</sup>
354.0	Mononeuritis of upper limb and	P	P	—	Dental technicians <sup>234</sup> .	Methyl methacrylate monomer. <sup>234</sup>
.2	mononeuritis multiplex (O)	P	P	—	Poultry processing—turkey <sup>11</sup> .	Cumulative trauma. <sup>11</sup>
.3					Meatpackers, deboners. <sup>250</sup>	Cumulative trauma. <sup>250</sup>
357.7	Inflammatory and toxic neuropathy (O)	P	P,T	P,T	Pesticide industry <sup>112</sup> , pigments, pharmaceuticals formulators. <sup>63</sup> Furniture refinishers, degreasing operations. <sup>111</sup> Plastic-coated-fabric workers <sup>24</sup> . Explosives industry <sup>107</sup> . Rayon manufacturing <sup>78,264</sup> . Plastics, hydraulics, coke industries. <sup>176</sup> Battery, smelter, and foundry workers. <sup>14,30</sup> Dentists <sup>127,236</sup> , chloralkali workers <sup>242</sup> . Chloralkali plants, fungicide makers, battery makers. <sup>56</sup> Plastics industry <sup>184</sup> , paper manufacturing <sup>144</sup> . Ethylene oxide sterilizer operator <sup>95</sup> .	Arsenic/arsenic compounds. <sup>63,112</sup> Hexane. <sup>111,226</sup> Methyl n-butyl ketone. <sup>24</sup> Trinitrotoluene. <sup>107</sup> Carbon disulfide. <sup>78,226,262,264</sup> Tri-o-cresyl phosphate. <sup>176,226</sup> Inorganic lead. <sup>14,30,78,226</sup> Inorganic mercury. <sup>127,236,242</sup> Organic mercury. <sup>56,78</sup> Acrylamide. <sup>144,184,226</sup> Ethylene oxide. <sup>95</sup>
366.4	Cataract (O)	P	P,T	—	Microwave and radar technicians. <sup>131</sup> Explosives industries <sup>107</sup> , trinitrotoluene workers <sup>105</sup> . Radiologists <sup>174</sup> . Blacksmiths, glass blowers, bakers. <sup>174</sup> Moth repellent formulators, fumigators. <sup>86</sup> Explosives, dye, herbicide and pesticide industries. <sup>187</sup> Ethylene oxide sterilizer operator, microbiology supervisors, inspectors. <sup>128</sup>	Microwaves. <sup>131</sup> Trinitrotoluene. <sup>94,105,107</sup> Ionizing radiation. <sup>94,174</sup> Infrared radiation. <sup>94,174</sup> Naphthalene. <sup>86,94,174</sup> Dinitrophenol <sup>174</sup> , dinitro-o-cresol. <sup>187</sup> Ethylene oxide. <sup>128</sup>
388.1	Noise effects on inner ear (O)	P	P	—	Occupations with exposure to excessive noise. <sup>188</sup>	Excessive noise. <sup>188</sup>

(continued)

Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\* (Continued)

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process /occupation	Agent
443.0	Raynaud's phenomenon (secondary) (O)	P	—	—	Lumberjacks <sup>139,209</sup> , chain sawyers, grinders, chippers, <sup>253</sup> rock drillers <sup>48,49,216</sup> , stone cutters <sup>254</sup> , jackhammer operator <sup>52</sup> , riveter <sup>216</sup> . Vinyl chloride polymerization industry <sup>64,141,149</sup> .	Whole body or segmental vibration. <sup>48,49,52,139,209,216,253,254</sup> Vinyl chloride. <sup>64,126,141,149</sup>
493.0, 507.8	Extrinsic asthma (O)	P	P,T	P,T	Jewelry, alloy and catalyst makers. <sup>35,196</sup> Polyurethane <sup>150</sup> , adhesive, paint workers. <sup>35,200</sup> Alloy, catalyst, refinery workers. <sup>35</sup> Solderers <sup>35</sup> . Plastic, dye, insecticide makers. <sup>35</sup> Foam workers, latex makers, biologists. <sup>35</sup> Printing industry <sup>35</sup> . Nickel platers <sup>35</sup> . Bakers <sup>35,256</sup> . Plastics industry <sup>35,197</sup> , organic chemicals manufacture. <sup>283</sup> Woodworkers, furniture makers. <sup>35</sup> Detergent formulators <sup>35</sup> . Crab processing workers <sup>44</sup> . Hospital and geriatric department nurses. <sup>96,157</sup> Laxative manufacture and packing. <sup>36,90</sup> Prawn processing workers <sup>82</sup> . Snow crab processing workers <sup>41</sup> .	Platinum. <sup>35,196,198</sup> Isocyanates. <sup>35,150,198,200</sup> Chromium, cobalt. <sup>35</sup> Aluminum soldering flux. <sup>35</sup> Phthalic anhydride. <sup>35,198</sup> Formaldehyde. <sup>35</sup> Gum arabic. <sup>35</sup> Nickel sulfate. <sup>35</sup> Flour. <sup>35,256</sup> Trimellitic anhydride. <sup>35,197,198,283</sup> Red cedar (plicatic acid) and other wood dusts. <sup>35</sup> <i>Bacillus</i> -derived exoenzymes. <sup>35</sup> Unknown. <sup>44</sup> Psyllium dust. <sup>96,157</sup> Psyllium dust. <sup>36,90</sup> Unknown. <sup>82</sup> Unknown. <sup>41</sup>
495.4	Maltworker's lung	P	P	—	Maltworkers <sup>93,215</sup> .	<i>Aspergillus clavatus</i> . <sup>93,215</sup>
495.5	Mushroom worker's lung	P	P	—	Mushroom farm/spawning shed, <sup>248</sup> farmer <sup>32</sup> .	Pasteurized compost. <sup>32,248</sup>
495.8	Grain handler's lung	P	P	—	Grain handlers <sup>67</sup> .	<i>Erwinia herbicola</i> ( <i>Enterobacter agglomerans</i> ). <sup>67</sup>
	Sequoiosis	P	P	—	Red cedar mill workers <sup>46</sup> , woodworkers <sup>47</sup> , sawmill <sup>51</sup> , joinery <sup>83</sup> .	Redwood sawdust. <sup>46,47,51,83</sup> <i>Thuja plicata</i> . <sup>46,47,83</sup>
495.9	Unspecified allergic alveolitis	P	P	—	Cinnamon processing workers <sup>261</sup> . Distillery <sup>72</sup> , vegetable compost plant worker <sup>267</sup> .	Cinnamon dust, cinnamaldehyde. <sup>261</sup> <i>Aspergillus fumigatus</i> . <sup>72,267</sup>

(continued)

**Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\* (Continued)**

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process/occupation	Agent
					Sawmill worker <sup>255</sup> .	Unknown. <sup>255</sup>
					Paper manufacture/wood room. <sup>228</sup>	<i>Alternaria</i> , wood dust. <sup>228</sup>
					Snow crab processing worker <sup>41</sup> .	Unknown. <sup>41</sup>
500	Coalworker's pneumoconiosis	P	P	P	Coal miners <sup>114,177</sup> .	Coal dust. <sup>114,121,177</sup>
501	Asbestosis	P	P	P	Asbestos industries and utilizers. <sup>21,143,183</sup>	Asbestos. <sup>21,121,143,183,232</sup>
502M <sup>k</sup>	Silicosis	P	P	P	Quarrymen, sandblasters, silica processors <sup>15</sup> , mining, metal, and ceramic industries. <sup>186,284</sup>	Silica. <sup>15,121,186,227,284</sup>
	Talcosis	P	P	P	Cryolite refining <sup>175</sup> .	Cryolite (Na <sub>3</sub> AlF <sub>6</sub> ), quartz dust. <sup>175</sup>
					Talc processors <sup>135</sup> , soapstone mining/milling, polishing, <sup>23</sup> cosmetics industry. <sup>179</sup>	Talc. <sup>23,135,179</sup>
503 M <sup>l</sup>	Chronic beryllium disease of the lung	P	P	P	Beryllium alloy workers, ceramic and cathode ray tube makes, nuclear reactor workers. <sup>104,269</sup>	Beryllium. <sup>104,269</sup>
504	Byssinosis	P	P	P	Cotton industry workers <sup>28,170,185</sup> .	Cotton, flax, hemp, and cotton-synthetic dusts. <sup>28,170,185</sup>
506.0 .1	Acute bronchitis, pneumonitis, and pulmonary edema due to fumes and vapors (O)	P,T	P,T	P,T	Refrigeration, fertilizer, <sup>146</sup> oil refining industries <sup>178</sup> .	Ammonia. <sup>146,178</sup>
					Alkali and bleach industries. <sup>178</sup>	Chlorine. <sup>178</sup>
					Silo fillers, arc welders, nitric acid industry. <sup>80</sup>	Nitrogen oxides. <sup>80,178</sup>
					Paper and refrigeration industries, oil refining. <sup>178</sup>	Sulfur dioxide. <sup>178</sup>
					Cadmium smelters, processors. <sup>178</sup>	Cadmium. <sup>178</sup>
					Plastics industry <sup>110</sup> .	Trimellitic anhydride. <sup>110</sup>
					Boilermakers <sup>145</sup> .	Vanadium pentoxide. <sup>145</sup>
					Organic chemicals manufacture <sup>283</sup> .	Trimellitic anhydride. <sup>283</sup>
570, 573.3	Toxic hepatitis (O)	P	P	P	Solvent utilizers, dry cleaners, <sup>19,168,241</sup> plastics industry <sup>153</sup> .	Carbon tetrachloride <sup>203</sup> , chloroform <sup>26</sup> , tetrachloroethane <sup>153</sup> , trichloroethylene <sup>13,19,241</sup> , tetrachloroethylene. <sup>168</sup>
					Explosives and dye industries. <sup>31,107</sup>	Phosphorus <sup>31</sup> , trinitrotoluene. <sup>107,237</sup>
					Fire and waterproofing additive formulators. <sup>118,134</sup>	Chloronaphthalenes. <sup>118,134</sup>
					Plastics formulators <sup>164</sup> .	Methylenedianiline. <sup>164</sup>
					Fumigators <sup>115</sup> , gasoline and fire extinguisher formulators. <sup>192</sup>	Methyl bromide. <sup>115</sup> Ethylene dibromide. <sup>192</sup>

(continued)

**Table I. Occupationally Related Unnecessary Disease, Disability, and Untimely Death\* (Continued)**

ICD-9	Condition	A <sup>a</sup>	B <sup>b</sup>	C <sup>c</sup>	Industry/process/occupation	Agent
					Disinfectant, fumigant, synthetic resin formulators. <sup>119</sup>	Cresol. <sup>119</sup>
584, 585	Acute or chronic renal failure (O)	P	P,T	P,T	Battery makers, plumbers, solderers. <sup>229</sup>	Inorganic lead. <sup>229</sup>
					Electrolytic processes, arsenical ore smelting. <sup>116,201</sup>	Arsine. <sup>116,195,201,229</sup>
					Battery makers, jewelers, dentists. <sup>229</sup>	Inorganic mercury. <sup>229</sup>
					Fluorocarbon formulators, fire extinguisher makers. <sup>229</sup>	Carbon tetrachloride. <sup>98,229</sup>
					Antifreeze manufacture <sup>22</sup> .	Ethylene glycol. <sup>22</sup>
					Chromate pigment production workers <sup>58</sup> .	Inorganic lead. <sup>58</sup>
606	Infertility, male (O)	P	P	—	Kepones formulators <sup>38</sup> .	Kepones. <sup>38</sup>
					DBCP producers, formulators, and applicators. <sup>71,223,276</sup>	Dibromochloropropane. <sup>71,223,276</sup>
692	Contact and allergic dermatitis (O)	P,T	P,T	—	Leather tanning, poultry dressing plants, fish packing, adhesives and sealants industry, boat building and repair. <sup>4</sup>	Irritants (e.g., cutting oils, phenol, solvents, acids, alkalis, detergents); allergens (e.g., nickel, chromates, formaldehyde, dyes, rubber products). <sup>217</sup>
733.9 M <sup>m</sup>	Skeletal fluorosis (O)	P	P	—	Cryolite workers (grinding room) <sup>92</sup> .	Cryolite (Na <sub>3</sub> AlF <sub>6</sub> ). <sup>92</sup>
					Cryolite refining workers <sup>175</sup> .	Cryolite (Na <sub>3</sub> AlF <sub>6</sub> ). <sup>175</sup>

\*External causes of injury and poisoning (occupational), including accidents, are classified in the ICD-9 under the E codes. References for Table I follow the main References section. Reference numbers inside commas and inside periods apply only to the immediately preceding category; those outside of periods apply to all prior categories pertaining to a particular agent or process.

<sup>a</sup>A, unnecessary disease.

<sup>b</sup>B, unnecessary disability.

<sup>c</sup>C, unnecessary untimely death.

<sup>d</sup>P, prevention.

<sup>e</sup>T, treatment.

<sup>f</sup>Original ICD rubric = Cutaneous Diseases Due to Other Mycobacteria.

<sup>g</sup>From the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM).<sup>280</sup>

<sup>h</sup>M, modified ICD rubric.

<sup>i</sup>Original ICD rubric = Malignant Neoplasm of Liver and Intrahepatic Bile Ducts.

<sup>j</sup>Original ICD rubric = Mononeuritis of Upper Limb and Mononeuritis Multiplex.

<sup>k</sup>Original ICD rubric = Pneumoconiosis Due to Other Silica or Silicates.

<sup>l</sup>Original ICD rubric = Pneumoconiosis Due to Other Inorganic Dust.

<sup>m</sup>Original ICD rubric = Other Disorders of Bone and Cartilage.

condition, separate columns identify the particular industry or occupation in which the condition has been noted to occur from the literature survey. Another column notes the etiologic agent for the disease condition. Like the 1983 Table A-(O), the up-dated list indicates whether the manifested unnecessary disease, unnecessary disability, or untimely death can be controlled by prevention and/or treatment.

## DISCUSSION

Use of the ICD-9 classification system as a basis for cataloging SHE(O)s, although convenient, is not without drawbacks. The ICD system was developed as a way of examining mortal events. Thus there is an underrepresentation of health events that lead only to morbidity. In the context of occupational medicine, such important conditions as carpal tunnel syndrome and other chronic repetitive trauma disorders are not specifically noted in the ICD system. This problem is circumvented by the use of "modified" codes (denoted with an "M" in Table I). Moreover, one recently identified infectious disease of occupational concern, human immunodeficiency virus (HIV), is not represented in the ICD-9 manual. Thus, for this condition, the clinical modification of the ICD-9 has been used here [World Health Organization, 1986].

Moreover, it should be noted that the so-called "E codes" (those ICD rubrics that address the classification of accident-associated events ascribable to external causes) are not included in Table I. Most accidental injuries and deaths occurring in an occupational setting will be classified within these E codes. Exclusion of these codes from Table I was for brevity's sake and due to the self-evident occupational relatedness of their occurrence. A compilation of these codes is available, however, and will be provided to interested individuals upon request.

Despite increasing recognition of the role that work plays in wellness and health, occupational medicine continues to remain outside the mainstream of U.S. medicine [Bingham, 1989]. Medical curricula continue to give regrettably short shrift to teaching occupational medicine [Levy, 1980, 1985; Markowitz et al., 1989]. Thus, when presented with a patient whose illness may or may not be occupationally related, the undertrained health care provider may fail to ask the appropriate questions concerning work history that may lead to substantiation of occupational disease. Indeed, the importance of asking such questions has been recognized for centuries. To the requisite questions posed during interview of the patient, Ramazzini [1713] "would presume to add one interrogation more: namely, what trade he is of." These diagnostic failures are detrimental not only to the patient, but they underserve the worker population at large as well, since failure to recognize occupational illnesses precludes application of material(s) substitution, engineering control technology, and personal protective equipment, where implementation of such equipment or controls could prevent further illness. Deficiencies in reporting and combining case reports (even when recognized) into an effective surveillance system leads to a sense of false security about the level of workers' health [Markowitz et al., 1989].

As noted in the 1983 SHE(O) article, Table I was envisioned to have three uses: 1) as a list to assist the practicing physician in the recognition of occupational diseases; 2) as a framework for developing a national system for occupational health surveillance; and 3) as a periodically up-dated database of occupationally related diseases to assist occupational health researchers. Since publication of the 1983 SHE(O) list, the SHE(O) concept has been applied or adapted to a number of arenas

that involve the practicing physician. The American College of Physicians has endorsed its use in the education of physicians concerning occupational medicine [American College of Physicians, 1984], as have others [Sokas, 1984].

A recent application of the SHE(O) system is in the training of primary care residents (Personal communication, 1989, Dr. Gerri Kahn, Internal Medicine Program, Medical Education Department, MacNeal Hospital, Berwyn, Illinois). Here, SHE(O)s will be used to computerize patient information for surveillance purposes and as a framework for physician education.

For surveillance purposes, Table I has proven useful for analysis of death certificate data for indications of work-related mortality [Dubrow et al., 1987; Feldman and Gerber, 1990; Lalich and Schuster, 1987; Naor and Lemieux, 1986; Wagner and Buffler, 1989]. The linkage of a SHE(O) to a particular ICD code ensures usefulness for this purpose, since virtually all of these databases are coded by ICD. High-speed data processing is thereby facilitated, and tentative leads for epidemiologic follow-up can be identified. Such analyses are expedited when additional information concerning the industry or occupation of the decedent is available. In 1983 there were four states coding industry and occupation (I/O) on death certificates. Since then, an additional 30 states have begun this coding. (The National Institute for Occupational Safety and Health continues to conduct training courses for individuals interested in I/O coding.)

The SHE(O) concept may also be applied to the analysis of hospital discharge data in the surveillance of occupational disease [Blanc, 1989; Fontus et al., 1989; Muldoon et al., 1987]. In New Jersey, hospital discharge data were used to generate maps of the geographical distribution of selected SHE(O)s [Rosenman, 1988]. Although this analysis was limited to the SHE(O)s for which additional industry and occupation information is not required (silicosis and asbestosis), the analysis nonetheless yielded important information that led to the identification of major deficiencies in the protection of workers at several worksites as well as in the identification of additional workers suffering from silicosis.

The utility of the SHE(O) concept for occupational disease surveillance at the state level using birth certificates, cancer registries, noncancer disease registries, and workers' compensation claims has been explored [Key, 1985; Rosenman, 1988; Wegman, 1984; Weinstein et al., 1989]. Workers' compensation systems, in particular, offer an effective means of quantifying and typifying occupational illnesses and injuries. Analysis of workers' compensation data using occupational sentinel health events in Ohio has proven to be an effective form of "case follow-back" [Seligman et al., 1986].

Physician surveillance of their patient populations for quantifying the societal burden of occupational illnesses and identifying remedial actions has also been proposed [Fontus and Levy, 1987]. Further, physician case reports of SHE(O)s can serve as an effective means of identifying and controlling occupational illness [Blanc and Olson, 1988; Liss et al., 1986]. Occupational SHEs may also serve as the basis for a system of occupational disease surveillance in areas of mandatory physician reporting [Freund et al., 1989].

A program of active occupational disease surveillance based among health care providers has recently been enacted by the National Institute for Occupational Safety and Health, Centers for Disease Control [Matte et al., 1989]. This program, the Sentinel Event Notification System for Occupational Risks (SENSOR) will assist in

providing meaningful trend data for the SHE(O)s targeted as reportable conditions. Laboratory-based surveillance of occupational sentinel health events has also been undertaken. In California, surveillance of laboratory results for overexposure to lead has been successfully implemented [Rudolph et al., 1989].

Finally, the up-dated SHE(O) list (Table I) continues to serve as a compilation of disease conditions known to be work related. Its attraction here lies in the ease of up-dating the list, as well as in the linkage between health condition and worker populations among whom the condition may be expected to occur. Despite the advances made in occupational health practices, occupational diseases continue to afflict the U.S. workforce. Moreover, as the nature of work and industrial production evolves, occupational diseases present an ever-changing specter. Continued vigilance over the science that documents the relationship of disease and work coupled with vigorous implementation of remedial action is vital to successful control of occupational illness. We believe that the occupational sentinel health event concept will assist in these efforts.

## ACKNOWLEDGMENTS

We extend special thanks to James Lockey, MD, Director, Occupational Medicine Program, University of Cincinnati Medical Center, and Robert G. Feldman, MD, Chairman, Department of Neurology, Boston University, for their timely review of two of the new disease conditions in the up-dated SHE(O) list.

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