Overview: Problems and Opportunities in Standardization of Information Transfer in Operating Rooms and Intensive Care Units

Just before the joint ISO TC 121 and ASTM Committee F29 Symposium on Operating Room and Intensive Care Alarms and Information Transfer, the London *Financial Times* described a hospital complete with "smart card admission, bedside expert systems support, digitized radiography, and doctors' handwriting recognition systems" [*1*]. Sixteen different areas representing departments such as admissions, intensive care, radiology, etc., are built around a seven million dollar implementation of the Health Level 7 Communications Standard [*2*], allowing interaction of equipment from some 40 different suppliers. The open architecture allows information such as a diagnosis from a frozen section taken in the operating room to be transferred automatically to pharmacy, medical records, billing, etc., as appropriate. Cost reduction, decentralization, and the need to release medical staff from administration to improve clinical care are driving the health care business the world over. "The significance of open architectures to hospitals is that single-vendor solutions have palpably failed to deliver," the *Financial Times* concludes [*1*]. The forty symposium participants concurred.

Yet the problems of information transfer in the operating room and the intensive care unit are even more complex in some ways than in the rest of the hospital because the proportion of real-time signal processing applications is higher [*3*]. Typically, much of the information is derived from waveforms such as electrocardiograms, arterial, or venous pressure traces, or electroencephalograms. For interpretation, the computer requires several devices including sensors to detect the signal in analog form, transmitters, and amplifiers and converters to digital values [*4*]. If closed loop control is used for control of neuromuscular blockade, ventilation, depth of anesthesia, fluid resuscitation, or drug infusion, then proportional integrative and derivative controllers will probably be required [*4*]. A medical information bus has been proposed to provide a local area network around the patient [*5*]. In the proposed ASTM standard specification for transferring digital neurophysiological data between independent computer systems [*6*] it is suggested that readily available universal media and formats be used such as digital radio tape with American National Standards Institute (ANSI) standard tape labels terminated by carriage return characters [*7*]. An example of network hardware and software suitable for transmission of waveform data would be Ethernet and the TCP/IP protocol. This specification is based on ASTM Standard Specification for Transferring Clinical Observations Between Independent Computer Systems (E 1238) [*8*], developed in cooperation with HL7 [*2*] with extensions to support the transmission of multichannel time series waveforms. *Physicians Current Procedural Terminology,* 4th edition, 1991 [*9*], and the *International Classification of Diseases,* 9th and 10th revisions [*10*] as well as the *Systematized Nomenclature of Medicine* [*11*] are used. Networking standards are based upon ISO 8072 [*12*]. To be effective, human factors guidelines must address human-computer interaction [*13*], especially in an environment as demanding as intensive care units and operating rooms.

The present cacophony of alarms in these environments is entirely inappropriate, as everyone at the symposium agreed. Hopefully, many of these issues are being addressed by the Inter-

national Organization for Standardization (ISO) [*14,15*] and ASTM standards that have been recently approved by ballot [*16*].

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