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The Nurse's Medication Day

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Abstract

The medication administration stage of the medication-use process is especially vulnerable to error because errors are least likely to be caught before reaching the patient. Medication administration, however, remains poorly understood. In this article we describe medication administration as observed in an ethnographic study conducted on one medical and one surgical unit. A central finding was that medication administration entailed a complex mixture of varied and often competing demands that temporally structured the nurses' entire workday. Articulation work was evident in time management strategies nurses used to handle demands from institutional policies, technical devices, patients, the physical environment, and the medications themselves. The average number of doses of medication per patient was more than double the number policy groups have indicated. Medication administration is neither simply the giving of drugs nor does it have clearly defined temporal boundaries. Because of its inseparability from other nurses' work, medication administration inherently entails interruption, thereby calling into question the current emphasis on reducing interruptions as a tactic to decrease medication errors.

Keywords

complexity; ethnography; health care; work environment; medication; nursing; quality of care; safety; patient; sociology

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According to policy groups such as the Institute of Medicine (IOM; Aspden, Wolcott, Bootman, & Cronenwett, 2007; Kohn, Corrigan, & Donaldson, 2000; Page 2004), medication errors are the most common errors in health care. Consequently, there is great interest in making the medication-use process safer. This process is typically viewed as having stages, with physicians, nurse practitioners, and physician's assistants ordering medications; pharmacists dispensing them; and licensed nurses administering them to patients. Although errors can "creep into this process at various" stages (Kohn et al., 2000, p. 37), the medication administration stage is vulnerable because errors are least likely to be intercepted at this stage before reaching the patient (Leape et al., 1995). Errors are defined as unintended acts including those of omission whereby a necessary action is not taken, commission whereby an incorrect action is taken (Leape, 1994), and near misses, or events "that could have resulted in bad consequences, but did not" (Reason, 1997, p. 118). Human factors engineering paradigms have been used to improve patient safety by designing delivery systems that better support the work of healthcare professionals (Karsh, Holden, Alper, & Or, 2006). Although attention has been directed toward improving the safety of

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ordering medications, other parts of the complex medication-use process—especially administration—remain less well understood (Aarts, Ash, & Berg, 2007; Walker & Carayon, 2009).

In this article, we describe the complexity of medication administration as observed in an ethnographic study. Drawing from our observations, we propose that several prevalent misconceptions persist about the medication administration process and the role nurses play in it. One misconception is that medication administration is about simply giving patients drugs that have been ordered by physicians and dispensed by pharmacists (Aspden et al., 2007). Glossed here are the actions nurses routinely take to ensure the accuracy of ordering and dispensing medications. Medication administration is commonly also viewed and studied as work separable from other work nurses perform (Biron, Lavoie-Tremblay, & Loiselle, 2009; Elganzouri, Standish, & Androwich, 2009; Keohane et al., 2008), that is, as having identifiable beginnings and endings and therefore measurable frequency and duration (Biron et al., 2009; Elganzouri et al., 2009; Keohane et al., 2008). This idea has contributed to the prevailing belief that medication errors can be reduced by streamlining and decreasing interruptions to medication administration (Biron et al., 2009; Elganzouri et al., 2009; Hall, Pedersen, & Fairley, 2010). We found that medication administration is inseparable from other nursing work, which challenges the very idea that other nursing work and the work of medication administration can interrupt each other.

Method

The findings featured here were derived from data generated in an ethnographic study of turbulence in hospitals. Turbulence was defined as the disorder and turmoil that characterize contemporary hospital environments. Approved by both university and hospital institutional review boards, the study was conducted from November of 2008 through June 2010 on one medical and one surgical unit in a 581-bed acute care community hospital located in the southeastern United States. Data were generated from 267 hours of field observations; 29 1-hour interviews with registered nurses (RNs), license practical nurses (LPNs), nursing assistants, unit clerks and physicians; and from key documents, including national regulations, hospital policies governing medication use, and data collected by the hospital on medication use. We decided to focus one of our first analysis efforts on medication administration when it became apparent to us from both field observations and interviews how much of the nurse's day was defined by medication administration.

To capture this key thematic line, we borrowed the concept of “the medication day” from Bresalier, McCoy, and Mykhalovskiy (2002, p. 75) who described the complex temporal process involved in the work HIV-positive persons perform to take antiretroviral medications. Applied to medication administration in hospitals, the idea of the medication day captures the “routines and activities that [nurses] …repeat day after day … [although] each day is unique” (Bresalier et al., p. 76). This complex “dose by dose” (McCoy, 2009, p. 128), drug by drug, and patient by patient medication work far exceeds mere adherence to the six “rights” of medication administration (i.e., right dose, right drug, right patient, right route, right time, right documentation; Potter, 2010). Moreover, as a form of “time work” (McCoy, 2009, p. 130), medication administration “dictate[s] the daily rhythm of nursing activities …determining the temporal structure of nurses' entire workday” (Zerubavel, 1979, p. 28).

To capture the temporality integral to the work of medication administration, we used sociological concepts of time to interpret data, including duration (how long events last); sequencing (the order of events), and timing (when events occur; Flaherty, 2003; Zerubavel, 1976); frequency (how often events occur; Flaherty, 2003); tempo (the pacing of events;

Zerubavel, 1976); and synchronization (the coordination of one's work with that of others; Waterworth, 2003). Because time is seen as finite (Schwartz, 1974), workers are urged to use time efficiently and productively (Flaherty, 2003; Schwartz, 1974; Southerton, 2003), heightening their consciousness of time management. Because waiting and idle time are viewed as counterproductive (Schwartz, 1974), workers are urged not to “waste” time (Davies, 1994; Flaherty, 2003; Southerton, 2003; Waterworth, 2003).

Sample and Setting

The primary participants for the analysis featured here were the 143 RNs and 18 LPNs who gave medications on the study units. Fifteen of the 161 nurses (9%) were men. Most of the nurses were permanently assigned to either the study units or the hospital float pool used to supplement staffing. Nurses on the medical unit averaged 43 years of age (range=24-60); on the surgical unit, 42 years of age (range=23-58); and in the float pool, 46 years of age (range=30-60). Their experience as nurses ranged from those who, as new graduates, had no experience to those with 35 years of experience. The nurses' longevity on the medical unit averaged 7 years; on the surgical unit, 9 years; and in the hospital float pool, 15 years.

Data Collection

Field observations—Observations were conducted by the first author in increments of about 3 hours each covering the full 24-hour day and all days of the week. Notes were taken openly and transcribed immediately after leaving the field (Emerson, Fretz, & Shaw, 1995). Grand tour observations were used at the start of the study followed by more focused observations (Spradley, 1980). The centrality of medication administration to the nurses' day became especially apparent while shadowing 13 nurses—11 RNs and 2 LPNs; 7 on the day shift and 6 on the night shift—for at least 3 hours on each of two sequential days. These nurses often commented that medication administration was “time-consuming” and “never-end[ing].”

Formal interviews—For the analysis featured here, we extracted information also from the 24 interviews in which aspects of medication administration were addressed. These face-to-face interviews were conducted by the first author away from the units; they were audio-taped and then transcribed verbatim. Although the interview questions were initially designed to explore turbulence, during the first several interviews, participants spontaneously introduced information about medication administration, such as when they talked about good and bad shifts being determined by the number, timing, and nature of the medications they had to give and aspects of medication administration as entailing turbulence. Because medication administration was mentioned so often in the early interviews, a probe about it was added to subsequent interviews.

Documents review—Documents relevant to this analysis included monthly medication records for each unit as well as written hospital policies. The monthly medication records, provided by an informatics analyst, were requested by the first author soon after medication administration was identified as a theme in the observational data. These records were in the form of spreadsheets containing de-identified information from the electronic medication record generated by the barcoded medication administration (BCMA) system. The informatics analyst calculated the average doses of medications given to patients each month on each unit as well as the percent of medications that were routine and the percent that were unscheduled, along with providing information about the age of patients on the study units. Medication error rates were not provided to us on advice of the hospital attorney. We were, however, shown graphs illustrating that errors related to medication administration steadily declined from the time the BCMA system was introduced in 2006. (No errors of commission or omission were observed during the course of the study, although—as we describe in more detail in the results section— near misses were observed when the BCMA system alerted nurses to potential mistakes and when nurses intercepted mistakes in pharmacy profiling.) Nurse managers provided information about the age and experience of their respective nursing staffs. Written documents pertinent to medication administration from external organizations such The Joint Commission (TJC; 2009a, 2009b), in addition to laws such as the Controlled Substances Act (DOJ, 2007), provided a context within which to interpret these medication data.

Data Analysis

Analysis began as soon as field notes and interviews were transcribed after each observational period and interview session. The data were organized by unit and chronologically based on the date and time of the observations within units, by informant, and by data type (i.e., field note, interview, written documents) with links to related content created between these elements. All data were managed via Microsoft® Word and Excel software.

Almost from the outset, the first author experienced Forester's notion of "thinking with your fingertips" (unpublished and un-dated paper cited in Emerson et al., 1995, p. 146) whereby writing and reflection stimulate each other. Analytic notes were embedded in the transcripts, including questions and ideas to pursue in subsequent observations and interviews, as well as thoughts, impressions, and references to relevant literature. Analytical and procedural memos were written in concert with the two other authors throughout the life of the project. All transcripts were initially open coded as a preliminary way to sort and organize the data into sensitizing concepts (Emerson et al., 1995; Hammersley & Atkinson, 2007). A key example of this is the synthesis and categorization of data via the concept of "demands."

All data pertaining to medication administration were also arranged into sets of matrices to enable comparisons to be made, for example, between and among units, times of day, nurses, medications, and other key elements. The investigators met frequently for ongoing analysis. In addition, as our findings took shape, they were regularly presented to participants for evaluation. The data collection process itself involved constantly asking clarifying and probing questions of informants such as "I'm seeing you wait for medications. Why is that?; You mentioned that it was hard to get to the medications at times, can you tell me more about that?" This process in addition to the time spent in the field increased the likelihood that data saturation was achieved. Participants also spontaneously sought the first author out while in the field with such comments as "I want to make sure you know this," and "Here's another example of what we were talking about the other day." A written summary of findings related to medication administration was also given to five staff nurses, an assistant nurse manager, and the nurse manager from each unit. Two supervisory staff members also asked for and were given copies. Comments from these individuals about the summary indicated that we had captured much of the complexity of medication administration as they experienced it and in a way that added to their understanding of it.

Findings

The nurses' medication day unfolded within the temporal boundaries of their shift (Zerubavel, 1978), involving numerous scheduled and unscheduled medications that were ordered for their patients. Nurses faced a complex mixture of demands related to medication administration that had to be completed within the temporal structure of their shift. Managing time was the dominant strategy used by nurses to deal with the demands associated with administering medications.

The Temporal Structure of the Medication Day

Each 24-hour work cycle was organized around two main shifts—7:00 a.m. to 7:00 p.m. and 7:00 p.m. to 7:00 a.m. The temporal markers (Zerubavel, 1979) were set for each shift by the medication schedule, with nurses using these markers to check if they were “running late.” A good medication day was one in which patients were not “on a lot of meds” scheduled so close together that timeliness was difficult to achieve. On a good day, nurses had time to enter rooms throughout the shift to interact with patients and family members, and to assess patients' status, without the concurrent responsibility of giving medications. In contrast, a bad medication day was one in which nurses were unable to give patient their “full attention,” rushing through care just to “keep up, especially with meds.”

Number of doses of medications—The number of medications taken by most patients on the units observed, with many requiring multiple doses per day, expanded the duration and otherwise affected the tempo of medication work. On the medical unit, scheduled doses per patient per day averaged 25 and on the surgical unit 22. PRN (*pro re nata*, as needed) medications accounted for 7% of the doses per patient per day on the medical unit, or an average of 2 doses per patient per day in addition to the scheduled doses, and 14% of the doses per patient per day on the surgical unit, or an average of 4 additional doses. These data indicate that the IOM's “conservative” (Aspden et al., 2007, p. 111) assumption of 10 doses per patient per day seriously underestimated the actual doses given. Moreover, in the IOM report, no distinction was made between scheduled and unscheduled medication doses (Aspden et al., 2007).

Scheduled medications—Administration times for scheduled medication spanned the full 24-hour day. For example, medications ordered every 4 hours were given at 2:00 a.m., 6:00 a.m., 10:00 a.m., 2:00 p.m., 6:00 p.m., and 10:00 p.m. Twice-a-day medications were scheduled for 10:00 a.m. and 10:00 p.m., although diuretics were scheduled for 10:00 a.m. and 6:00 p.m. to minimize patients having to urinate at night. Bedtime medications were given at 10:00 p.m. Most daily medications were timed for 10:00 a.m., although drugs that needed to be taken on an empty stomach were scheduled for 6:00 a.m. and anticoagulants that were adjusted based on laboratory results were scheduled for 6:00 p.m. Because 25% of all doses were scheduled for 10:00 a.m. on the study units, it was known as the “main med pass.” Seventeen percent of doses were scheduled for 10:00 p.m., with the remaining 58% of the medications given throughout the remainder of the 24-hour day. Although other investigators have reported that the majority of doses are administered between 8:00 a.m. and 10:00 a.m. (Carayon et al., 2007; Elganzouri et al., 2009), the distribution of doses throughout the remainder of the day is rarely addressed.

Unscheduled medications—Unscheduled medications altered the temporal rhythm of the medication day. The two main types of unscheduled medications were those ordered STAT (*statim*, immediately) or PRN. Although routine and expected parts of the medication day, unscheduled medications were paradoxically also interruptions to the routine because they occurred at unplanned times and thereby created discontinuities in work (Brixey, Robinson, Johnson, Johnson, Turley & Zhang, 2007). STAT medications were to be given within 30 minutes of being ordered, requiring nurses to stop other work to give STAT drugs. Patients most often requested PRN medications for pain relief; nurses put these requests “first,” altering the sequencing and tempo of nurses' work. As one nurse stated, “five minutes [in pain] feels like 20 to the patient,” thereby distinguishing between clock and process time (Davies, 1994). Clock time dominates views of time, but is often at odds experientially with process time. When process time dominated, patient needs became the priority.

The Demands of Medication Administration

Within the temporal structure of the medication day, nurses had to manage a host of varied and often competing demands related to medication administration. These demands emanated from the: (a) institutional policies governing medication administration; (b) technical devices associated with medication administration; (c) patients receiving the medications; (d) physical environment of the unit; and from the (e) medications themselves.

Institutional demands—Hospital policies were designed to ensure that the institution complied with longstanding regulations and standards as well as the glut of new rules and guidelines that followed the first IOM report on medication errors (Kohn et al., 2000). Regulations came from many sources including accrediting agencies such as The Joint Commission (TJC; 2009a, 2009b), laws such as the Controlled Substances Act (CSA; DOJ, 2007), and numerous private organizations with no official authority but considerable influence such as the Institute for Safe Medication Practices (ISMP; 2010).

To comply with TJC standards and the legal demands of the CSA, several classes of drugs required actions by two nurses. For example, adjustments to doses of high-risk medications such as anticoagulants and insulin required two nurses to calculate the doses separately, a redundancy to safeguard against errors (ISMP, 2010; TJC, 2009a). Many calculations were straightforward; others were more complicated, like the 13 steps in the transitional insulin order set. The CSA dictated many parameters for administering drugs with the potential for abuse (e.g., many analgesics; DOJ, 2007). Two nurses had to participate in “wasting” controlled substances: one to dispose of the unused portion of the drug, one to witness the action. Likewise, two nurses were involved if a controlled substance was returned to storage, although returning was quicker than wasting.

In 2004, TJC accrediting standards for medication management became more prescriptive and detailed (Rich, 2004). All medication orders, for example, were to be reviewed by a pharmacist to ensure there were no contraindications prior to dispensing the medications. Known as “profiling,” this safety check requires pharmacists to construct and maintain the patient's medication list or profile. Except for emergencies, medications were not to be given until they were profiled. On the units observed, delays in profiling of up to 90 minutes were common. Moreover, nurses often discovered mismatches between orders and profiles, giving rise to comments like “pharmacy misprofiles all the time.” Eighteen near misses were observed related to nurses finding mistakes made by the pharmacy related to the patient's medication profile. Nurses intercepted these mistakes, calling the pharmacy, and then waiting for the profiles to be corrected. These interceptions illustrate a dynamic in Reason's (1997 in Reason's (2000) “Swiss cheese model” whereby nurses served as a barrier, protecting patients from a potential hazard. Calls to the pharmacy were also common to request “missing meds” followed by waits until they were delivered. Waiting reflected system failures like those Biron et al. (2009), Hall et al. (2010), and Tucker and Spear (2006) reported. The time it took to call for missing items was wasted time (Southerton, 2003; Waterworth, 2003).

Multiple demands derived also from documentation requirements. The essential components of a BCMA system include individually prepackaged medications, each having a unique barcode that is readable with an optical scanner; an optical device used to scan both the medication package (or intravenous solution) and a barcode on the patient's identification band; and computer software that links to an electronic medication administration record (eMAR). Although the BCMA system automatically documented the five “rights” (drug, patient, dose, time, route) along with the date of administration and the name of the nurse giving the medication, this did not fulfill all documentation requirements. To maintain compliance with TJC standards, for instance, nurses had to record a thorough description of patients' needs for PRN drugs and an assessment of their effectiveness within one hour after administration. Technical devices such as patient-controlled analgesia (PCA; a pump connected to an intravenous [IV] catheter that allowed patients to self-administer a narcotic analgesic) escalated documentation requirements because an assortment of patient parameters had to be recorded at set intervals.

Fire codes and TJC standards mandated that hospital hallways remain clear (NFPA, 2007; TJC, 2009b), creating demands associated with the BCMA system. The BCMA optical scanner was attached to a computer on wheels (COW), a laptop computer situated on a mobile pedestal. Nurses could not leave or "park" their COWs in the hallway when they were not in use. Each time nurses had to give a medication, they first had to retrieve their COWs from the designated parking areas, which were not always near the medication rooms.

Numerous hospital-specific policies also affected the temporal structure of the medication day. According to the policy, medications were to be scheduled on even hours. The pharmacy, however, could schedule them at other times, yielding occasions when patients had medications due hourly. Nurses believed that "pharmacy holds the reins, control[ling] whether your shift is good or bad" because pharmacists did not always set medication administration times based on the policy. When even a couple of patients required medications every hour, the time demand on the nurse increased exponentially because of the numerous steps involved in medication administration (as detailed later in this article).

The nurses' medication day was affected by additional hospital policies such as those related to meal times. Medications like short-acting insulin had to be given just before or with meals which, for these units, were to arrive at 7:30 a.m., 11:30 a.m., and 4:30 p.m. The actual meal delivery times varied, arriving from 30 to 60 minutes on either side of the scheduled times. Nurses had to monitor the timing of meal service to coordinate with insulin administration, giving it neither too early nor too late or even overlooking it. The demand of coordinating insulin administration and meal service escalated for the 7:30 a.m. dose because of the concurrent work of changing shifts, creating the possibility that an insulin dose might "slip through a crack." Nurses were the hospital team members who most often had to adjust their work to the work of others, reflecting a lack of synchronization among members of the care team (Waterworth, 2003).

Demands of technical devices—The numerous technical devices nurses interacted with throughout the day created their own demands separate from whether the devices functioned or malfunctioned (cf. Treiber & Jones, 2010). Some of these devices were integral to medication administration—alarms on safety devices such as "smart" IV pumps used with almost every patient prompted nurses to find the source of the alarm, then determine and manage its cause, creating interruptions (Biron et al., 2009; Carayon et al., 2007). Other devices, such as the cordless phones nurses were required to carry, facilitated communication but also made nurses constantly accessible (Hall et al., 2010).

Many relatively simple devices were essential to administering medications, such as medication cups, syringes, needles, tubing, tape, gloves, and alcohol wipes. Nurses used blood pressure cuffs and stethoscopes to evaluate patient vital signs prior to giving certain medications; they used glucometers to determine whether patients needed insulin and if so, how much. More complex devices included Automated Medication Dispensing Cabinets (AMDCs), BCMA, "smart" IV pumps, and PCAs. These devices have been touted by policy organizations such as the IOM (Aspden et al., 2007; Page, 2004) as solutions for improving safe medication practices. The various complex devices were implemented in the hospital at least 3 years prior to this study and the nurses were adept in using them.

The almost constant need for technical devices often altered the tempo of medication work by slowing it down. For example, alcohol wipes were sometimes out-of-stock in the patient rooms. Some technical devices were in short supply at certain times of the day, creating periods of waiting. Glucometers were always in high demand at meal times and bedtime. The AMDCs located in the medication rooms were in almost constant use. Both units had two AMDCs, with each AMDC designated for patients in a specific location. Accordingly, three to four nurses, in addition to a respiratory therapist and the pharmacy technicians who restocked them, shared the AMDCs throughout the day. Although nurses viewed the AMDCs as “safe” and a “time-saver,” some AMDC features, such as verifying the number of medications remaining, slowed down obtaining medications (cf. Balka, Kahnamoui, & Nutland, 2007). Additional medication delays associated with the AMDCs occurred when a medication was out-of-stock, a common occurrence for frequently given medications.

The COWs created demands associated with their weight (67 pounds) and maneuverability; both male and female nurses regarded them as heavy, cumbersome, and difficult to push. Nurses talked about hurting their backs and hips from “dragging” the COWs. By the end of a medication day, it was common for nurses to experience sore shoulders from pushing their COWs to each patient's room every time they gave even one dose of medication and then back to the designated parking area.

Devices also created demands when they malfunctioned, “slowing” nurses down and “throw[ing them] off schedule.” For example, although BCMA systems made the “five rights foolproof,” nurses frequently had to scan the barcoded medication packets multiple times as well as patients' barcoded armbands (cf. Carayon et al., 2007; Koppel, Wetterneck, Telles, & Karsh, 2008; Novak & Lorenzi, 2008). Repeated scanning was inefficient as it increased the duration of medication administration. One nurse was observed scanning the same medication packet eight times before the BCMA system recognized it. Despite these delays, nurses knew the BCMA system would reflect precisely when they gave medications, “sensitiz[ing] nurses to the medication schedule in a new way” (Novak & Lorenzi, 2008, p. 518). Seven near misses were observed involving alerts from the BCMA system that precluded nurses from making potential mistakes. These near misses were in addition to those involving nurses' interceptions of pharmacy misprofiling.

Patient demands—Patients' physical and mental capacities, along with their preferences and requests, created another set of demands on the nurses' medication day. This was especially evident when nurses had 13 pills, an injection and IV antibiotics to give to one patient at one medication pass as they often did. Patient demands also increased if a patient was added to the nurse's assignment or there was a change in a patient's condition.

Demands related to the patients' age also affected the duration of medication administration (average age of medical patients was 65 [range=19-102]; average age of surgical patients was 62 [range=16-97]) because of issues with patients' ability to swallow, level of independence, and cooperation with medication administration. Many patients swallowed only a few pills at a time, with the nurse helping them finesse the right combination based on the pills' size. Some patients needed the nurse to place the pills in their mouths, requiring the nurse to don gloves. For other patients, nurses had to crush their pills and then mix them with applesauce to facilitate swallowing; nurses regarded crushing medications as the most time-consuming aspect of actually giving medications. As Novak and Lorenzi (2008, p. 517) observed, nurses often had to “find creative ways to get patients to take their medications.” Combative or otherwise uncooperative patients placed special demands on nurses to find the right technique to coax them into taking their pills, allowing injections to be given, or cooperating while eye drops were instilled.

Throughout the medication day, nurses assessed patients' medication needs that ranged from anti-anxiety drugs and antipyretics (to reduce fever) to anti-emetics (to reduce nausea and vomiting) and antacids. Nurses often had to call physicians to request an order for these medications. Nurses also called physicians requesting orders to be renewed such as expired insulin orders on patients whose glucose values remained above normal. If physicians returned calls promptly, the demand was minimized, obviating the need for nurses to make another request.

Nurses anticipated spending as much as 20 minutes in each room during a medication pass because they knew that patients would take advantage of their presence and make requests. A frequent request involved assisting patients to the bathroom, an event complicated by the technical devices to which most patients were tethered. In this study, extremes were observed such as an occasion when it took 45 minutes to give medications to a single seriously ill patient with numerous needs.

The rhythm of the entire medication day could be altered by one patient, whether an additional patient in the nurse's assignment or a patient whose condition was unstable or declining. Nurses typically cared for five patients on days and six on nights. Occasionally, they were assigned one more patient than usual, potentially turning a single medication pass into a 120- to 140-minute event. If nurses spent more than 20 minutes with a patient or other demands emerged during the medication pass (e.g., frequently checking on a patient recently admitted from the post-anesthesia care unit or giving PRN medications), a medication pass could exceed the “on-time” window defined by hospital policy as an hour before to an hour after the scheduled time. If a patient's condition was unstable, that patient dominated the nurse's time. In extreme circumstances, such as when the rapid response team was called, medication work for other patients in that nurse's assignment came to a standstill until the crisis was over.

Other patient demands also altered the temporal rhythm of the medication day. For example, blood administration occurred frequently. This involved checking the blood with another nurse prior to hanging it, remaining with the patient during the first 15 minutes of the infusion, and checking vital signs 30 minutes before the transfusion, every 15 minutes for the first hour of the transfusion, and at the completion of the transfusion.

Demands of the physical environment—Policy groups such as the IOM have questioned whether the physical design of patient care units affects efficiency and patient safety (Page, 2004). Missing from such discussions is how the physical environment creates demands specifically related to medication administration and the dilemmas of using 21st-century technologies designed to improve quality and patient safety in 20th-century hospital structures.

In this study, many of the patient safety practices had to be retrofitted into the 40-year old hospital. The strong commitment to keep hallways clear and free from safety hazards created a demand to make parking spaces for the COWs. These parking areas needed to have sufficient electrical outlets so the COWs could be plugged in to keep their batteries charged. To minimize bending and squatting, it was highly desirable for the outlets to be situated waist-high, which was achieved in only some of the parking areas.

Nurses commented that two medication rooms were insufficient; they identified medication rooms as places of turbulence because of the high demand to use them. Because the AMDCs filled the medication rooms, the COWs had to remain outside. Constraints were also posed by the small size of the patient rooms (cf. Koppel et al., 2008) aggravated by the clutter in them (cf. Battisto, Pak, Vander Wood, & Pilcher, 2009), often making it a tight squeeze to get the COWs far enough into patient rooms so the scanning device could reach the patient's armband.

Medication demands—Finally, the medications themselves created demands based on attributes such as the nature of the drugs and their routes of administration. Antibiotics exemplified drugs that, by their nature, escalated demands on nurses. They could put nurses behind in giving scheduled medications. Nurses, therefore, set a goal of "staying up with antibiotics" that were typically given multiple times each day; the drug-related demands were repeated with each administration. For example, an antibiotic ordered for serious bacterial infections, Piperacillin (Zosyn), was not pre-mixed by the pharmacy. Nurses had to reconstitute the drug every time a dose was needed. This took extra planning because Zosyn had a reputation for being "a bear to mix. It's like glue"; it also took about 10 minutes to dissolve.

When multiple antibiotics were scheduled at the same time for a single patient—a frequently observed occurrence—nurses experienced increased demands. They had to go into the patient's room multiple times to give medications for a single medication pass, bringing their COW with them each time. When three antibiotics were scheduled concurrently, it was sometimes impossible to administer all of them within the on-time window, especially if infusions were slowed to ease the burning some patients experienced. Still, nurses preferred juggling antibiotics scheduled concurrently to having medications scheduled every hour.

Of the various routes of drug administration, three accounted for 91% of the doses given on the study units. On average, the most common route was parenteral (via needle; 45%), followed by oral (42%), and enteral (via tube; 4%). The parenteral route consisted of four subtypes—intravenous (IV), intramuscular (IM), subcutaneous (SC), and intradermal (ID).

Demands from IV medication administration were reduced when patients had IV fluids running continuously. Frequently, however, patients who did not need medications or fluids infusing constantly had their IV lines capped between uses, a practice known as "plugging" or "hep-locking" because a solution was instilled into the IV lines to prevent clotting. Plugging involved instilling a normal saline solution into the line to keep it patent; hep-locking involved instilling a heparin solution. The type of IV determined the type solution used. Once plugged or hep-locked, patients had more freedom of movement between doses of medication, but it took more of the nurses' time to reestablish the IV infusion and, when it was completed, "plug" the line again.

Although only 4% of the doses were given by the enteral route, they posed a unique set of demands. For instance, if patients were getting continuous feedings through an enteral tube, the nurse had to stop the feeding 30 to 120 minutes prior to giving medications. In addition, nurses had to take several actions to prepare the medications, give them, and clear the tubing after the medications were administered.

Managing Time

Nurses found it "nearly impossible to distinguish med administration from other tasks; it seems like it never ends." Accordingly, nurses used time management strategies—a form of articulation work (Star, 1991; Star & Strauss, 1999; Strauss, 1985, 1988)—to handle the medication-related demands that emanated from institutional policies, technical devices, the patients, the physical environment, and the medications themselves. Articulation work "refers to the specifics of putting together tasks, task sequences, [and] task clusters…in the service of work flow" (Strauss, 1988, p. 164). Articulation work is the "counterpoint" (Star, 1991, p. 275) to routine, rationalized work, coming into play when unexpected occurrences and breakdowns occur. Although invisible, articulation work gets and keeps things on track despite contingencies. Because it appears natural and routine, articulation work is usually taken for granted. Workarounds are forms of articulation work performed to circumvent system impediments that interfere with achieving goals (Koopman & Hoffman, 2003). Although these actions are intended to increase efficiency, they sometimes violate prescribed hospitals practices (Battisto et al., 2009; Carayon et al., 2007; Koppel et al, 2008). For instance, despite expectations that patients would wear their identification bands, when patients were combative or rooms were extremely congested, nurses placed the identification bands on the foot of the bed or on over bed tables.

Sequencing medication administration—Nurses moved from room to room in no immediately discernible pattern during medication passes, choosing the sequence based on patient demands not the numeric room order. The goal was to administer as many medications “on time” as possible. Patients who needed their medications crushed were placed at the end of a medication pass, improving the chances of giving other patients' medications on time. Conversely, patients with several IV antibiotics scheduled concurrently were put first in the sequence to aid in administering them within the allocated timeframe. To maximize efficiency, nurses reprioritized tasks (Tucker & Spear, 2006), converting waiting into usable time. For example, instead of waiting while pharmacy created or corrected medication profiles or sent missing medications, nurses diverted their efforts to accomplish other patient care activities to avoid wasting time.

Clustering care with medication administration—Nurses took advantage of their time in patient rooms during medication administration to cluster other care (Strauss, 1988). They changed dressings, completed patient assessments including evaluating pain and taking vital signs, read parameters from monitoring equipment, and interacted with patients and families. Nurses gave as many medications as possible at once; 8 o'clock and 10 o'clock medications were administered at 9 o'clock to manage time. If patients requested pain medication, nurses also gave all scheduled medications within the acceptable timeframe to “make one visit do.”

Multitasking during medication administration—Multitasking—a reflection of timing or when events occur (Flaherty, 2003; Zerubavel, 1976)—involved doing several tasks simultaneously (Southerton, 2003) rather than sequentially. For instance, nurses were adept at bending their heads to one shoulder to secure their phones while talking. This allowed them concurrently to use their hands to draw-up, scan, or give medications; push their COWs; or get medications from the AMDCs. They also talked with patients and family members and addressed care questions from other staff members while doing the work of medication administration.

Individualized techniques for managing temporal load—Some strategies to stay up with the demands of medication administration were adopted by nurses because “it works for me.” One such timesaving technique was to keep all medication wrappers for each patient until all aspects of giving medications at a scheduled time were completed. If the computer malfunctioned, nurses could quickly rescan the wrappers rather than spend time digging them out of the trash to “start [scanning] from scratch.” Another technique was to create a list of each room in their assignment, the times medications were due, and the number of medications due at each time. At the end of a shift, “everything should be crossed off.” Southerton (2003) noted that list-making helped people stay on schedule despite impending temporal overload.

Discussion

Administering medications on the units observed was not a single activity—the giving of one or more drugs to one or more patients—but rather an orchestration of a host of diverse activities to manage the competing demands. Regardless of the unit, time of day, or day of the week, medication administration temporally structured nurses' workdays. Medication administration was not part of the nurse's workday with markers clearly separating it from other work, but rather it constituted the day.

The inseparability of medication administration thus calls into question not only the findings of studies based on the assumption that medication administration has identifiable beginnings and endings and measurable frequencies and durations, but also the very idea that errors can be reduced by decreasing interruptions to medication administration (Biron et al., 2009; Carayon et al., 2007; Elganzouri et al., 2009; Hall et al., 2010; Tucker & Spear, 2006; Westbrook, Woods, Rob, Dunsmuir, & Day, 2010). With no clearly identifiable beginning and ending, medication administration inherently entailed interruption; unscheduled medications served to interrupt the administration of scheduled medications, and medication administration itself served to interrupt other kinds of work. The very devices (e.g., “smart” IV pumps and BCMA systems) advocated by policy groups as ways to enhance the safety of medication administration (Aspden et al., 2007; Page, 2004) were interruptive, with BCMA systems appropriately interrupting near misses (Reason 1997, 2000) in medication administration to avoid errors of commission and to alert the nurse to impending errors of omission (Leape, 1994). The medication administration observed in our study suggests the futility of efforts to distinguish work from interruptions of work; the nature of the work of medication administration suggests that the work of the nurse in general entails interruption. Moreover, in the case of near misses or errors interrupted, interruptions may have a positive impact on patient safety.

Although clock time regulated medication schedules, giving medications involved blending clock time with process time (Davies, 1994). Administering even a single pill or injection often could not be accomplished within clock-time parameters due to patient needs and preferences as well as the medications themselves; indeed administering a single pill or injection was itself a rare occurrence. The complex temporal processes involved with medication administration take on heightened importance when considering that the number of medication doses given to patients in the course of our study was more than double assumptions used by the IOM (Aspden et al., 2007).

Contrary to prevailing understandings of medication work in hospitals, the nurses observed had key responsibilities not just for medication administration, but also for the ordering and dispensing of medications, stages typically viewed as in the domain of physicians and pharmacists, respectively. Our findings point to the lack of consensus about the very work involved in what is commonly referred to as medication administration and thus call into question how best to study this work. For example, Keohane et al. (2008) timed six activities, several with sub-steps, (obtaining and verifying medications, administering medication, managing medication orders, retrieving medication information, documenting medications, waiting inefficiently) seen to constitute medication administration. Battisto et al. (2009) timed five activities (retrieving, preparing, administering, and documenting medications plus monitoring IV pumps), and Elganzouri et al. (2009) measured four activities (retrieving, preparing, administering and documenting medications). Biron et al. (2009), Hall et al. (2010), and Westbrook et al., (2010) measured two activities (preparing and administering medications). These investigators all used structured observational tools to capture medication administration activities, thereby recording only the pre-identified activities. Sometimes observers followed nurses into patient rooms (Keohane et al.), while at

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other times, investigators situated observers outside patient rooms and relied on nurses to describe what took place inside the rooms (Battisto et al.; Elganzouri et al.). In addition, these studies were rarely conducted around the clock to capture the constraints of both clock and process time.

By not using a pre-structured tool, by following nurses throughout the units and into patient rooms, and by collecting data throughout the 24-hour day on all days of the week, we were enabled to render a more complete depiction of medication administration and of the articulation work nurses perform in bringing together the demands of institutional policies, patients, technical devices, and the medications themselves. We were able to see how the “human variability” (Reason, 2000, p. 770) nurses demonstrated in their articulation work and the lack of variability built into technologies such as the BCMA system operated together to offset error. We were able to bring to life (i.e., to make more dynamic) and thereby provide empirical support for the performance inputs and transformation process elements of the human factors engineering model Karsh et al. (2006) proposed for optimizing patient safety. In the language of their model, the demands of institutional policies, technical devices, patients, physical environment and medications along with the time-management strategies nurses used to address them described here constitute performance input factors and the physical, cognitive, and behavioral activities encompassed in transformation processes. In a more ethnographic vein, medication administration entails work the complexity of which has heretofore not been fully appreciated or documented. Those contemplating future studies of or alterations to the medication administration process would do well to understand this complexity and the dose-by-dose challenges of the nurse's medication day.

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