Managing **Spaghetti Syndrome** in Critical Care With a Novel Device: A Nursing Perspective

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BACKGROUND Managing "spaghetti syndrome," the tangle of therapeutic cables, tubes, and cords at patients' bedsides, can be challenging.
OBJECTIVES To assess nurses' perceptions of the effectiveness of a novel banding device in management of spaghetti syndrome.
METHODS A simple color-coded elastomeric banding strap with ribbed flaps was attached to bed rails of adult critical care patients to help organize therapeutic cables, tubes, wires, and cords. Nurses were surveyed before and after use of the bands and after the nursing shift to assess the burden of spaghetti syndrome and the effectiveness of using the bands.
RESULTS Use of the bands decreased the time spent untangling cords, reduced the frequency of contact of tubing with the floor, and diminished disruptions in care.
CONCLUSIONS Use of a simple flexible latex-free elastomeric band may help organize therapeutic tubing at patients' bedsides and may promote improvements in nursing care. (*Critical Care Nurse*. 2015;35[6]:38-45)

Critical care patients often have numerous therapeutic connections (eg, cords, cables, and tubes) at the bedside that can easily become disorganized and tangled, leading to contamination of the connections, nurses' confusion, a physical hazard that increases the risk for falls for both nurses and patients, and the possibility of damage of medical devices.[1-6] This phenomenon, known as spaghetti syndrome, makes caring for patients challenging and difficult[1,2] (Figure 1). Multiple instances of patients' deaths, permanent injury, and life-threatening situations related to entanglement with the cords of medical devices have been reported.[5,7-14] Ensuring the organization of cords and tubes at a patient's bedside may reduce adverse outcomes such as entanglement of the patient, backflow in tubing, falls by both patients and health care personnel, and connection errors or damage of medical equipment.[5-7,12]

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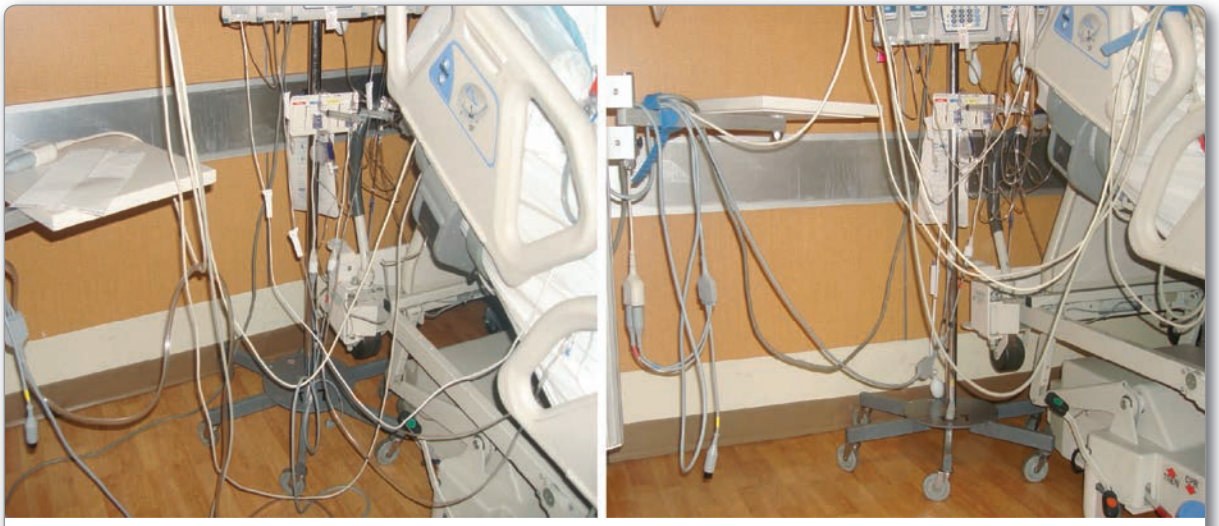

Figure 1 Managing "spaghetti syndrome": flexible sleeved-strap banding devices are used to secure therapeutic tubing, wires, and cords, keeping them off the floor and organized in a manageable state.

Therapeutic tubing, cables, wires, and cords are a fundamental aspect of daily health care for delivery of medications and fluids to patients. The often disorganized tubing and cords at the bedside increase the possibility of inadvertently connecting the wrong syringes and tubing and then unintentionally delivering medication or fluids via the wrong route. In 2006, the Joint Commission issued alerts on tubing misconnections; interventions and procedures to manage and protect medical cords, tubes, and cables as a standard of care, but only a few devices are available to aid in this task.[11,13,15]

Few bedside devices for cord control are commercially available, and they vary in complexity and design. The purpose of this study was to test use of a novel simple, sleeved-strap banding device in the management of spaghetti syndrome in a critical care unit and to assess nurses' responses to use of the band. Before the study, no devices or standard protocols were being used to manage the syndrome.

Methods

After a comparison of commercially available products, a novel sleeved-strap band crafted from elastomeric latex-free material (JanaBand, JMC Global Technologies) was chosen for the study. This device was selected because of its relative value, flexibility, and ease of application (Table 1, Figures 1 and 2). The color-coded sleeved banding devices were donated for the study by their creator and manufacturer, JMC Global Technologies, Keller, Texas.

In tests of the effectiveness of the device in an inpatient setting, 2 colors (red and blue) were used to distinguish between afferent tubing carrying medications or fluids into the patient and efferent tubing removing fluids from the patient or holding wires and cables (Figure 2).

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Table 1 Comparison of bedside devices

Feature	Comparison devices	Study device (JanaBand)
Cost	Variable depending on quantity	$5-$9 depending on quantity
Design	Clasp: securing holes are the same size and accommodate 3-4 tubes, cords, and/or wires, prefitted	Strap sleeve: larger opening allows for variety of tube sizes and numbers of tubes, cords, and wires
Material	Foam, rubber, and plastic	Latex-free elastomeric flexible strap
Attachment	Designed to fit on bedrail	Secures on multiple posts, including bedrails, and intravenous poles; can be adjusted for multiple sizes

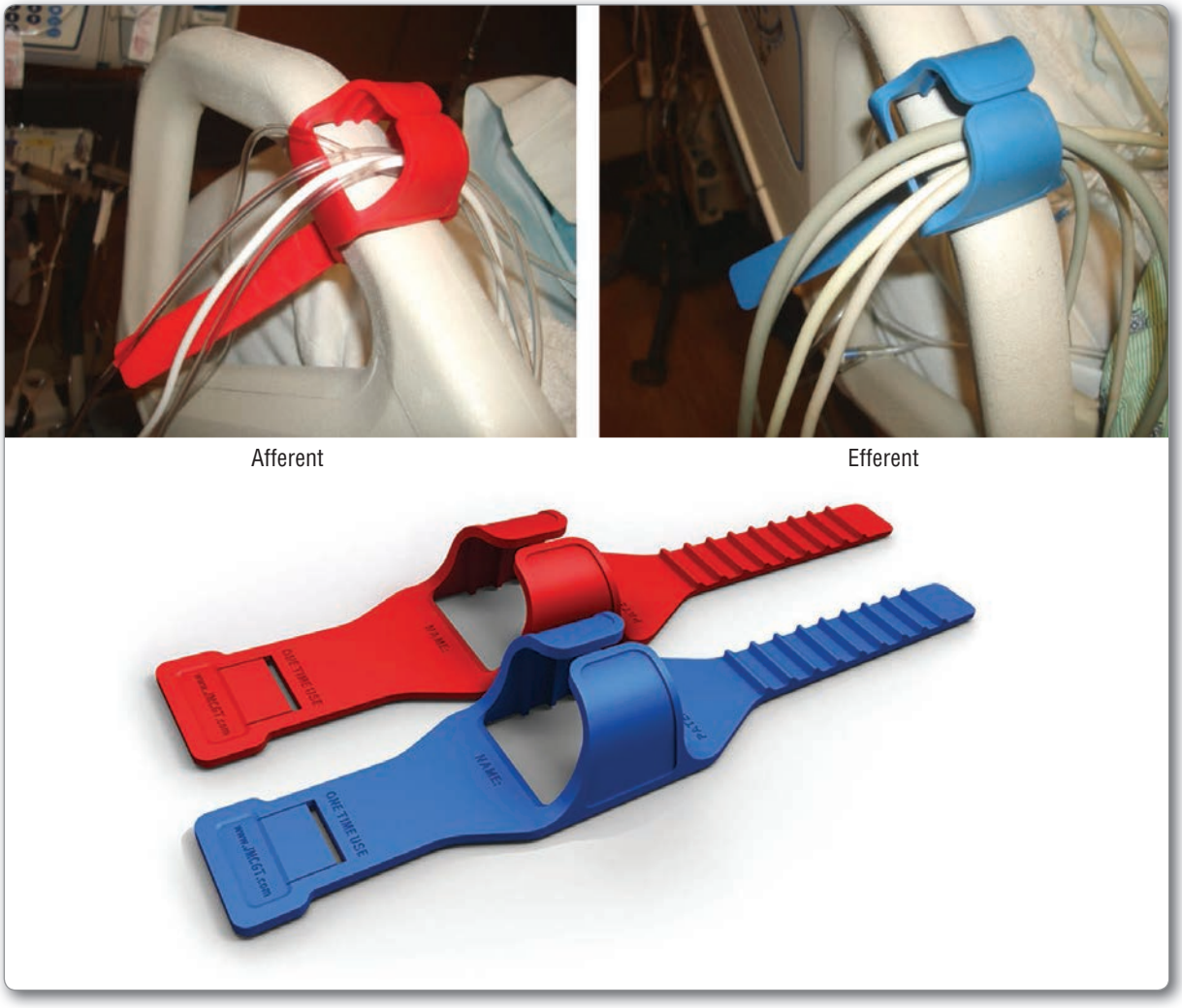

Figure 2 The JanaBand strap device system (JMC Global Technologies, Keller, Texas).

The banding device is approximately 29.2 cm (11½ in) long and 4.8 cm (1⅞ in) wide. The flap sleeves allow quick release and gliding of the therapeutic connections. In addition, the banding device added structure and strength to support a wide variety of sizes and weights of therapeutic tubing. In order to ensure sanitation, once a band is removed from a patient's bed, it cannot be reconnected and is therefore disposed of immediately. The intended use of the band is to manage spaghetti syndrome by bundling therapeutic tubing, wires, cables,

and cords at the bedside and to prevent the tubing from dropping to the ground and potentially becoming tangled, damaged, or contaminated (Figures 1 and 2).

During a 1-month period (October 2013), the effectiveness of the banding device was determined at a tertiary urban care hospital and academic medical center in an adult intensive care unit with 36 private patient rooms. The unit was staffed and monitored by 74 intensive care nurses; each nurse worked 12-hour shifts 3 days/week.

Several methods were used to teach the nurses how to use the banding device correctly. Nurses were introduced to the device during their rounding huddles or at meetings before the start of a shift. A member of the study team demonstrated how to attach the devices to the bed and how to remove them after each use. In addition, nurses received an e-mail with a link to an instructional video demonstrating proper use of the band. Additional educational sessions available to the nurses in the break room provided detailed pictures and directions on how to use the device and a contact number for study personnel if a nurse had questions about the band.

Of the 36 patient rooms 18 (50%) were selected for use of the banding device; the other 18 patient rooms served as control rooms, with no use of the device. Once the study rooms were identified, 2 sealed packages of the bands were placed by medical technicians at the patient's bedside before a new patient was admitted. In order to ensure consistency, nurses were instructed to place the banding device on the patient's bed rails, securing appropriate tubing, cords, and cables. This particular location for the banding device was chosen because of proximity to medical equipment and to avoid interfering with movement of the bed rails and the patient's mobility. The location was tested before the study to ensure consistency and to determine the ideal place for the bands.

Surveys

A voluntary survey consisting of 10 questions was administered before and after use of the bands. The purpose of the survey administered before use of the bands was to determine nurses' perceptions of the burden of the spaghetti syndrome in the critical care unit before the study took place. The survey given after use of the bands was used to measure nurses' perceptions of the effectiveness of the banding device.

Surveys after each nursing shift were completed voluntarily by nurses for each of the patient rooms monitored during their shift. Complete surveys were returned to a locked ballot box. This survey consisted of 3 multiple-choice questions on the nurses' perceptions of the frequency that therapeutic tubing and wires were tangled, disorganized, or damaged severely enough to disrupt care; the frequency that the tubing, wires, and cables were in contact with the floor; and the amount of time required to reorganize or untangle therapeutic cords, cables, and tubing to administer necessary care to the patient during the shift. On each survey, the respondent indicated if the banding device was used with the patient the nurse was describing and provided the room number for verification.

Statistical Methods

The data were analyzed by using SAS, version 9.2, software (SAS Institute Inc). Findings were considered significant at $\alpha = .05$. Survey items were summarized using descriptive statistics. A sample-size calculation was performed before the study to ensure that an adequate number of surveys were collected to achieve a statistical power of 80% during the 1-month study period. The responses from the survey given after the nurses' shifts were dichotomized, and χ^2 analysis with odds ratios was done to determine the differences in the number of disruptions in care, the number of times tubing may have been in contact with the floor, and the estimated time spent managing tubes, cords, and wires at the bedside with and without the use of the banding device. The Bowker test of symmetry was used to test for differences between the responses to surveys given before and after use of the bands. Because of small cell counts, several of the response categories on these 2 surveys were dichotomized as agree or disagree, and a zero-cell correction was used as necessary.

A simple flexible elastomeric sleeved latex-free banding strap can be used in the intensive care unit to help organize therapeutic tubing and may promote improvements in nursing care.

Results

Before Use of the Bands

A total of 43 surveys (58%) were collected before use of the bands. The results suggested that nurses were concerned about the management of spaghetti syndrome in the critical care unit (Tables 2-4). All 43 respondents acknowledged that a system for organizing therapeutic

Table 2 Survey questions and responses before and after use of strap band device: agree vs disagree questions

	Results before use of device (n = 43)		Results after use of device (n = 30)		*P*
Before question	Agree	Disagree	Agree	Disagree	
After question					
Cords, tubes, and cables are well organized around the patient's bed.	44% (n = 19)	56% (n = 24)	80% (n = 24)	20% (n = 6)	.04
When the strap band device was on a patient's bed, the cords, tubes, and cables were well organized.					
Our hospital has an effective solution for organizing bedside cords, tubes, and cables.	37% (n = 16)	63% (n = 27)	77% (n = 23)	23% (n = 7)	.007
Compared with our hospital's current method for organizing bedside cords, tubes, and cables, using the strap band device could be an effective solution.					
Patient bedside cords, tubes, and cables are often on the floor.	91% (n = 39)	9% (n = 4)	37% (n = 11)	63% (n = 19)	<.001
When the strap band device was used, patient bedside cords, tubes, and cables often fell on the floor.					
A system for bedside organization of cords, tubes, and cables would provide a comfortable and calming environment for the patient and the patient's family.	98% (n = 42)	2% (n = 1)	69% (n = 21)	31% (n = 9)	.005
Using the strap band device as a system for organizing therapeutic tubing provided a comfortable and calming environment for patients and their families compared with not using a banding device.					
A consistent system for the organization of cords, tubes, and cables would lead to improved efficiency for patient bedside care.	100% (n = 43)	0% (n = 0)	70% (n = 21)	30% (n = 9)	<.001
Using the strap band device system for the organization of cords, tubes, and cables would lead to improved working conditions during administration of patient bedside care.					
At shift change, I have to spend time reorganizing patients' cords, tubes, and cables.	84% (n = 36)	16% (n = 7)	63% (n = 19)	37% (n = 11)	.08
When strap band devices were being used, I had to spend less time at shift change reorganizing patients' cords, tubes, and cables.					
An organized, clean, and calm bedside environment contributes to a valuable health care experience.	98% (n = 42)	2% (n = 1)	73% (n = 22)	27% (n = 8)	.53
The strap band devices helped create a more organized, clean, and calm bedside environment and helped to contribute to a better health care experience.					

tubing and wires would improve the efficiency of patient bedside care, and 98% stated that the banding system would provide a more comfortable and calming environment for patients. In addition, 91% of the respondents acknowledged that the patient bedside cords, tubes, and cables were sometimes on the floor, and 84% reported that they were spending a large amount of time at shift change reorganizing the cords, tubes, and cables. The majority of the nurses (56%) thought that the tubing, wires, and cables around the patients' bedsides were not organized, and 93% thought the tubing, wires, and cables were apt to become tangled (Tables 2 and 3).

After the Nursing Shift

A total of 404 surveys were collected after nursing shifts during the 1-month study period. Of these, 55% described a nurse's encounter with a patient with the banding device, and 45% described an encounter without any banding device (Table 4). Survey responses indicated that if a banding device was in place on the bedrail, the patient was less likely to have a disruption in care due to problems with tangled therapeutic tubing ($P = .006$; odds ratio = 1.75; 95% CI = 1.18-2.61). Nurses were more likely to spend less than 1 minute organizing tangled tubing if a banding device was used ($P = .002$; odds ratio = 1.93;

Table 3 Survey questions and responses before and after use of a strap band device: how likely questions[a]

Question	Results before use of device (n = 43)	Results after use of device (n = 30)	*P*
How likely do you think it is that the tubing, wires, and cables may become tangled at the bedside?[b]			.03
Extremely likely	44% (n = 19)	10% (n = 3)	
Very likely	37% (n = 16)	17% (n = 5)	
Somewhat likely	12% (n = 5)	26% (n = 8)	
Not very likely	7% (n = 3)	47% (n = 14)	
Not at all likely	0% (n = 0)	0% (n = 0)	
How likely do you think it is that tubing, wires, and cables can become damaged in the bed rails?[b]			<.001
Extremely likely	23% (n = 10)	3% (n = 1)	
Very likely	37% (n = 16)	7% (n = 2)	
Somewhat likely	21% (n = 9)	30% (n = 9)	
Not very likely	19% (n = 9)	53% (n = 16)	
Not at all likely	0% (n = 0)	7% (n = 2)	
How likely do you think it is that tubing can become contaminated from being on the floor?[b]			<.001
Extremely likely	67% (n = 29)	6% (n = 2)	
Very likely	26% (n = 11)	6% (n = 2)	
Somewhat likely	7% (n = 3)	47% (n = 14)	
Not very likely	0% (n = 0)	40% (n = 12)	
Not at all likely	0% (n = 0)	0% (n = 0)	

[a] Because of rounding, not all percentages total 100.

[b] The categories extremely likely, very likely, and somewhat likely were combined to make a category, and the categories not very likely and not at all likely were combined to make a category for the statistical analysis.

Table 4 Impact in daily practice: survey results after nurses' shifts

Question	Percentage of group		
	Total sample (N = 404)	Banding device used	
		Yes (n = 223)	No (n = 181)
Banding device used			
Yes	55		
No	45		
No. of times care was disrupted because of tangles in therapeutic tubing[a]			
Never	56	62	48
Once	24	24	25
Twice	12	9	15
3 or more times	8	5	12
Extra time (minutes) spent untangling therapeutic tubing[a]			
<1	64	71	56
1-5	25	18	32
>5-10	8	7	9
>10-15	2	3	2
>15	1	1	1
No. of times therapeutic tubing was on the floor[a]			
Never	57	61	53
Once	22	25	17
Twice	11	8	15
3 or more times	10	6	15

[a] Statistically significant difference ($P < .05$) between the group that used the banding device and the group that did not.

95% CI = 1.29-2.91), and the therapeutic tubing was less likely to ever have been on the floor ($P < .001$; odds ratio = 2.53; 95% CI = 1.54-4.13).

After Use of the Bands

A total of 30 surveys (40%) were collected after use of the bands. Results suggested that using a banding device at the patient's bedside significantly aided in managing spaghetti syndrome (Table 2). A total of 80% of the respondents indicated that the banding device was effective in organizing therapeutic tubing and wires at the bedside ($P = .04$), and 69% indicated that the banding device accomplished the task of creating an organized, clean, and calm bedside environment ($P = .005$). The nurses indicated that, in general, the perceived likelihood of the risk of contamination from therapeutic tubing being on the floor was significantly decreased when the banding device was used ($P < .001$), as was the perceived likelihood of therapeutic tubing being damaged ($P < .001$) or being tangled in the bed rails ($P = .03$; Table 3).

Discussion

Introduction of a new process in health care usually meets some resistance and questioning. The results

suggested that before use of the banding device, nurses had genuine concerns about the management of bedside tubing and cords in the critical care unit. The results of surveys completed after use of the bands and after each nursing shift suggested that the nurses in this critical care unit thought that use of the new standard process with use of the color-coded banding devices had a positive impact on patient care. Use of the banding device to manage the therapeutic tubing yielded significant improvements in perceptions of efficiency and resulted in fewer disruptions in care and less nursing time spent untangling cords.

Nurses felt that the bands allowed a sense of organization, saved time, and had a potential for process improvement. The findings also indicate that use of the banding device might protect against damage to tubing, cables, and cords used at the patient bedside. Additionally, using a standard process of bundling and suspending tubing and cables with color-coded sleeved-strap devices may help differentiate clean from dirty tubing, minimize potential errors and damage to equipment, and may help create a more controlled, safe, and sanitary environment.

With a simple innovative focus on fundamental efforts to increase efficiency, decrease variability, and minimize risk and error, improvements may occur in both patient and employee satisfaction.

The results suggest that a quality benchmark might be achieved by implementing a routine standardized process that focuses on the prevention of entanglement of therapeutic tubing, cords, and cables by using a simple bedside apparatus such as a sleeved-strap banding device. Although spaghetti syndrome has been considered a serious patient care issue for many years, few studies have proposed a solution to this problem.[1-3,5,6,10,11,15,16] We hope that the results will reenergize the interest in solving the problem of spaghetti syndrome and lead to the development of protocols and standard processes for use of a simple solution to control entanglement of bedside tubing and wires for all hospitalized patients.

Limitations

Although the banding device was initially tested in several small internal pilot studies, with favorable results, the findings in this larger study are limited because the data are from a single critical care unit and were self-reported and voluntary. Thus, the results may not be applicable to other types of patient care settings. Although the results were favorable, the study was only 1 month long. For better understanding of the implications of using a banding cord-control device in a critical care unit, a longer study period is warranted to measure the health care outcomes and the impact on the delivery of the quality of care due to use of the band. Additionally, the impact of the process on infection risk or other clinical outcomes was not determined, so conclusions cannot be drawn about improvements due to use of the band in these types of outcomes. Although the results suggest that use of the banding device may lead to marked improvements in efficiency of nursing care, several nurses did not express any perception of improvements in the management of spaghetti syndrome. Some nurses even reported that use of the banding device added more time to tending to the tangle of therapeutic tubing. This finding could be attributed to the lack of familiarity with the new process. A longer study period in which nurses could become more comfortable with using such a device might yield different results.

Because the data were self-reported by the nurses, the information collected via the surveys reflects recall bias. Ideally, future studies should address this limitation by having dedicated observers gather quantitative instantaneous measurements about time and the number of times the therapeutic tubing became tangled or was in contact with the floor in the patients' rooms. The participation rate in the study decreased from 43 respondents in the survey before use of the banding device to 30 respondents in the survey after use of the device, and because of the voluntary and anonymous nature of the study, we could not determine if the nurses who completed the "before" survey also completed the "after" survey. In addition, we could not determine how many different nurses completed the surveys administered after the nursing shifts. Future studies should take this lack of specificity into consideration and determine a more unique method of reporting that maintains anonymity.

Conclusion

Our findings indicate that a simple flexible sleeved-strap banding device can be used in the intensive care unit to organize therapeutic tubing, cables, and wires at patients' bedsides and that use of the device may promote improvements in nursing care.

Our results also suggest that the banding apparatus promoted perceptions of improvements in efficiency and quality of nursing care. With a simple innovative focus on fundamental efforts to increase efficiency, decrease variability, and minimize risk and error, improvements might occur in patient as well as employee satisfaction.

If use of a color-coded banding devices could potentially protect and organize therapeutic tubing, cables, and wires at the bedside and reduce the risk and likelihood of error, then developing standard protocols for use of such devices should be considered and implemented. These results and the desire of nurses to improve patient care and increase safety in the workplace warrant future studies to investigate use of these bedside devices and the relative impact of their use to prevent damage or contamination of therapeutic tubing, cables, and cords; incidents of hospital-acquired infections; length of stay; and improvements in the quality and value of critical care. CCN

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None reported.

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References

1. Cesarano FL, Piergeorge AR. The spaghetti syndrome: a new clinical entity. *Crit Care Med.* 1979;7(4):182-183.
2. Imhoff M. The spaghetti syndrome revisited. *Anesth Analg.* 2004;98(3):566-567.
3. Wiegmann D, Eggman A, El Bardissi A, et al. Improving cardiac surgical care: a work systems approach. *Appl Ergon.* 2010;41(5):701-712.
4. White L, Dancer S, Robertson C, Robertson C, McDonald J. Are hygiene standards useful in assessing infection risk? *Am J Infect Control.* 2008;36(5):381-384.
5. Needham DM, Sinopoli DJ, Thompson DA, et al. A system factors analysis of "line, tube and drain" incidents in the intensive care unit. *Crit Care Med.* 2005;33(8):1701-1707.
6. El Bardissi AW, Sundt TM. Human factors and operating room safety. *Surg Clin North Am.* 2012;92(1):21-35
7. Bell JL, Collins JW, Tiesman HM, et al. Slip, trip, and fall injuries among nursing care facility workers. *Workplace Health Saf.* 2013;61(4):147-152.
8. World Health Organization. Avoiding catheter and tubing mis-connections. Patient Safety Solutions. Vol. 1. Solution 7. http://www.who.int/patientsafety/solutions/patientsafety/PS-Solution7.pdf. Published May 2007. Accessed August 26, 2015.
9. Sullivan C. IV tubing poses strangulation hazard, hospitals warned. *CMAJ.* 2002;167(5):529.
10. Guenter P, Hicks R, Simmons D, et al. Enteral feeding misconnections: a consortium position statement. *Jt Comm J Qual Patient Saf.* 2008;34(5):285-292, 245.
11. Joint Commission. Tubing misconnections—a persistent and potentially deadly occurrence. http://www.jointcommission.org/assets/1/18/SEA_36.PDF. Sentinel Event Alert, Issue 36. Published April 3, 2006. Accessed September 1, 2015.
12. Goodin HJ, Ryan-Wenger NA, Mullet J. Pediatric medical line safety: the prevalence and severity of medical line entanglements. *J Pediatr Nurs.* 2012;27(6):725-733.
13 Clark C. TJC warns hospitals of deadly medical tubing mistakes. Health Leaders Media, August 22, 2014. http://www.healthleadersmedia.com/page-4/FIN-307729/TJC-Warns-Hospitals-of-Deadly-Medical-Tubing-Mistakes. Accessed August 25, 2015.
14. Garros D, King WJ, Brady-Fryer B, Klassen TP. Strangulation with intravenous tubing: a previously undescribed adverse advent in children. *Pediatrics.* 2003;111(6, pt 1):732-734.
15. Sentinel Event Alert 53: Managing risk during transition to new ISO tubing connector standards. Published August 20, 2014. http://www.jointcommission.org/sea_issue_53/. Accessed September 10, 2015.
16. Ofek E, Pizov R. From a radial operating table to a self-contained operating table. *Anaesthesia.* 2006;61(6):548-552.
17. Wallin M, Wajntraub S. Evaluation of Bluetooth as a replacement for cables in intensive care and surgery. *Anesth Analg.* 2004;98(3):763-767.