



The downstream effects of the COVID-19 pandemic: The supply chain failure, a wicked problem

Karen Goldschmidt, PhD, MSN, RN, CNE *, Kelsey Stasko, BSN, RN

College of Nursing and Health Professions, Drexel University, United States

ARTICLE INFO

Article history:

Received 1 April 2022

Accepted 1 April 2022

Keywords:

COVID-19

Intensive care units, pediatric

Catheter-related infections

United states public health service

Evidence-based practice

ABSTRACT

The failure of the global supply chain became rapidly apparent at the beginning of the COVID-19 pandemic when healthcare organizations were left without supplies needed to care for patients. The supply chain failure is one downstream effect of the pandemic and indirectly impacts patient morbidity and mortality. This column presents a case study of one staff nurse's experience working in a pediatric intensive care unit at a rural children's hospital two years into the pandemic and the toll the global supply chain failure continues to take on patients and healthcare professionals. Central Line Blood Stream Infections (CLABSIs) are used to showcase the severity of the supply chain failure at the point of care. Standardized central line insertion and care bundles have proven to be effective in reducing the incidence of CLABSI; however, they are dependent on the availability of materials and supplies. Health care providers face a "wicked problem" in preventing CLABSIs. The failure of the global supply chain must be examined by healthcare organizations, manufacturers, and government officials so that new systems can be put into place, so we are prepared for a public health emergency.

© 2022 Elsevier Inc. All rights reserved.

It's hard to pick which was more dreadful, hearing the number of COVID patients in the Children's Hospital go up or hearing that we might run out of essential supplies that day. Pre-shift huddle started our day with dread and disappointment. Each day we learned about a new CLABSIs or HAPI that occurred or realized that we had three sets of blood tubing left. It got to the point that we were hoarding supplies and even trading supplies between units. "We'll give you a Biopatch®; if you give us three microbore tubings." How can a critical care unit function without supplies? We learned that due to the high demands of other hospitals, our supplier was running thin with supplies. Shortly after recognizing that, our hospital switched suppliers in hopes of quicker restocking. Our old supplier did not appreciate our switch and immediately stopped our supply chain. They were leaving us with limited supplies, leaving children with limited supplies, and leaving an entire intensive care unit praying that a cardiac arrest or mass casualty would not occur.

We had our stockpile of supplies that would get us through an arrest or small trauma if it occurred, but this meant that no other central line maintenance could be performed on the unit. Central lines need special care, and tubing and caps need to be changed frequently. Dressings and sterile cleaners need to be utilized to keep patients safe. We were doing our best to care for fragile children, but it grew more challenging to keep our patients safe each day because of the lack of supplies.

Globally more than 3.7 million deaths have been reported due to the COVID-19 pandemic; 13.4 thousand of these deaths were among children under 20 (United Nations Children Fund [UNICEF], 2022). Vaccination has effectively protected people from COVID-19 and lessened the severity of the illness. As the number of people vaccinated increases, deaths steadily decline, and COVID-19 infections are at their lowest point in two years. However, the pandemics' downstream effects continue to impact the morbidity and mortality of patients and, in turn, the mental wellbeing of health care providers who remain on the front line. The global supply chain failure is one downstream effect of the COVID-19 pandemic that indirectly affects patient morbidity and mortality. In a survey conducted with 80 healthcare systems, 90% of hospitals reported challenges in the procurement of supplies throughout the pandemic (Gooch & Gonzalez, 2021).

This column will present one staff nurse's experience working in a pediatric intensive care unit at a rural children's hospital two years into the pandemic and the toll the global supply chain failure continues to take on patients and healthcare professionals. Although this experience may not be nurses' experience in larger urban hospitals, nurses need to understand the broader effects of the supply chain failure and consider how resources are distributed to care for all patients.

Central Line Blood Stream Infections (CLABSIs), considered a never event, will be used as one example of how supply chain failure impacts patient morbidity and mortality. The purpose of presenting this case study from a staff nurses' perspective is to showcase the severity of the supply chain failure at the point of care, bring this issue to the

* Corresponding author.

E-mail addresses: Kag69@drexel.edu (K. Goldschmidt), Ks3948@drexel.edu (K. Stasko).

attention of healthcare and political leaders, and sound the alarm that solutions are needed sooner rather than later.

The global supply chain -a wicked problem

Over the past two decades, supply chains developed a “lean” methodology to streamline product distribution and decrease costs (Bhaskar et al., 2020). Lean methods are a process improvement method to meet consumers' needs without creating waste (NEJM Group, 2018). The lean method came out of the manufacturing industry (i.e., Toyota Production System) and other hybrid methods (i.e., Lean Six Sigma, etc.). Over the past twenty years, many healthcare organizations adopted the method (e.g., Virginia Mason Production Management System [VPMS]). The lean methodology has improved healthcare in countless ways, reducing patient wait times, patient throughput, and output, to name a few (NEJM Group, 2018; VMPS, 2010). Throughout the COVID-19 pandemic, one of the lean principles, “minimize inventory,” has surfaced as an issue for car manufacturers and the healthcare industry. Reducing redundancies for optimal system efficiency is an important goal and not to be abandoned; however, there is a need to reform the global supply chain to “strike a balance between efficiency and resilience” (Bloomberg, 2021, para 16).

The lack of supplies was endangering our patients. We could not provide the care we owed to them. It resulted in so many kids getting worse. Since we had to ration our supplies, kids went without crucial line changes. Per our hospital policy, IV tubing was changed every 96 h, and central line dressings were changed at a minimum of every seven days. To add to our dreadful pre-shift huddle, we started hearing that one of our patients was beginning to “chew through” his central line tubing and were told to “keep an eye on him.” A few huddles later, we hear that the kiddo spiked a fever. There goes another set of tubing after we draw blood cultures. Then we hear that he’s hypotensive—another line change for adding vasopressors to support his blood pressure. Then we hear that he’s our watcher patient and might get intubated. Our fragile patients were already in a compromised state and couldn’t fight off an infection that infiltrated their line. We saw where we failed, but how could we come back from this? We were still rationing supplies, taking goods from other units, and keeping our patients afloat. We struggled to find a solution to a problem that we never expected to happen.

Nurses and other clinicians working in healthcare systems are at the mercy of the availability of products purchased on the institution's behalf. It is not unusual for pediatric nurses to see changes in tubing, medication vials, labeling, and manufacturers throughout a given year. In the U.S., working in a pandemic with rationing supplies will undoubtedly shift healthcare professionals' perspectives on the materials used and what is available.

Technological advances made to equipment within the past two decades were done to improve the quality and efficiency of healthcare delivery and maintain an environment of patient safety. For example, smart pumps were developed and embedded with drug libraries to reduce the risk of error. Smart pumps are rendered useless without specialized tubing or tubing suitable for substitution for an infusion. Healthcare organizations have had little choice throughout the pandemic but to revert to using earlier versions of drug infusion pumps because there is no tubing available. For example, pumpless pressurized balls that deliver chemotherapy over 46 h must look like they are out of the dark ages to newer nurses!

Now we’ve been told that there will be several weeks between shipments of supplies. Before this, we were promised that items would be restocked within a few days, and it took weeks! Items like 1.7 ml coag tubes for blood were scarce (now essentially gone), so we were left with 2.7 ml coag tubes that require more blood from patients (this is critical because infants less than 2.5 kg do not have this much blood to spare).

Then they sent us different supplies from what we usually use –chest tube atriums, arm boards, and IV catheters were all different. The change in supplies required further education for the staff to remain vigilant so that nothing went wrong, and no one acquired an injury. Our shortages even extended into pharmaceuticals. We recently experienced a Fentanyl shortage, which we primarily use for sedation. Because there was no Fentanyl, many children needed to be transitioned to other drugs like Dilaudid and Morphine or needed an increase in the use of benzos like Versed. The transition from one drug to another was not smooth and resulted in needless suffering and frustration for patients, families, and staff. Patients experienced significant withdrawal or adverse reactions, and families watched helplessly. Staff worked begrudgingly under these almost ridiculous conditions.

The failure of the global healthcare supply chain became rapidly apparent at the beginning of the pandemic and is a “wicked problem” that needs resolution. Wicked problems are complex problems with multiple factors and interdependencies (Rittel & Webber, 1973). When solving a wicked problem, each solution reveals another issue that needs resolution (Periyakoi, 2007; Rittel & Webber, 1973). Those seeking answers to wicked problems often have conflicting views on how they approach the problem and view it from a perspective that works for their environment; they fail to appreciate how the problem and their solution affect the whole.

Never events

Over the past two decades, healthcare teams have worked relentlessly to bring down the rates of “never events” or preventable health care errors (Centers for Medicare & Medicaid Services [CMS], 2006). CLABSIs are considered a never event. While these infections are preventable, many exist because of failures from healthcare providers and organizations. This avoidable risk falls within the healthcare provider's scope of practice to intervene and implement change, especially nurses. In 2008 CMS stopped providing hospitals with full reimbursement for care required for patients after a CLABSI. The prevalence of CLABSIs costs individuals their health and lives and hospital systems excessive money.

CLABSI prevention bundles

Globally, CLABSIs are a significant problem for patients in intensive care units (ICUs) and a common hospital-acquired infection (HAPI) in pediatric and neonatal intensive care units (Ista et al., 2016). Standardized central line insertion and care bundles have proven to reduce the incidence of CLABSI (Bell & O’Grady, 2017; Centers for Disease Control and Prevention [CDC], 2020; Ista et al., 2016). Central line bundles have significantly reduced patient morbidity and mortality and health care costs with an estimated \$42,609 savings for each CLABSI prevented (Ista et al., 2016). Ideally, the number of reported CLABSIs on any unit is zero.

We pledged no CLABSIs and other hospital-acquired complications, and we had done a good job of meeting this goal for years; this was an enormous accomplishment. But as materials and resources needed to maintain that prestigious status dwindled, so too did the energy and effort to maintain it. During the 2021–2022 fiscal year, our rates of CLABSIs increased 3-fold.

CLABSIs are due to numerous preventable factors that affect patients in the pediatric intensive care unit. In addition to insufficient supplies, other factors can lead to CLABSIs. Some practitioners may find it challenging to maintain sterility when line insertion occurs during a patient resuscitation or if a patient's secretions infiltrate the sterile field. In addition, it can be difficult to protect lines from dislodgement if the practitioner chooses a precarious place for line insertion (e.g., femoral vein).

If equipment generally used for changing central line dressings is replaced with sub-par dressing, it can lead to poor adherence to the skin of chronically ill children. Ill-fitting dressings must be tampered with to fit the patient. The dressing is often soiled with excessive diaphoresis, emesis, secretions, and stool. Defective supplies that do not adhere well to the patient may need multiple dressing changes before the due date—exposing the line to more providers and pathogens.

Multiple factors play a role in generating a CLABSI. Upon insertion, clinicians need to follow sterile technique. They utilize evidence-based practices such as handwashing, sterile gloves, and 2% chlorhexidine, decreasing infections by over 60% (Bell & O'Grady, 2017, para. 13).

CLABSI rate of zero- -can this be maintained?

Health care providers and institutions have made significant strides in making “never events” a top patient safety priority. Looking specifically at CLABSIs, studies dating back to 2013 indicate that central line bundles effectively reduce them (Ista et al., 2016). However, there may have been an underlying assumption that the supplies to deliver optimal care were abundant and would always be available. Before the pandemic, U.S. nurses may not have given much thought to the number of materials required to care for patients, or the amount required to keep one patient with a central line CLABSI free.

The Centers for Disease Control and Prevention (CDC, 2020) published a CLABSI prevention checklist for the care of central lines. Each hospital adopts a bundle for its patient population so that costs will vary; however, this checklist provides a microscopic view of the number of materials required to care for one patient. One part of this checklist states, “Ensure efficient access to supplies for central line insertion and maintenance (i.e., create a bundle with all needed supplies)” (CDC, 2020, para. 9). Given the number of materials required to care for one patient with a central line, the scarcity of materials, or sub-par replacement materials requiring the use of more than one (e.g., using more dressings because the adhesive on substitute dressing is inadequate to adhere to patient's skin for extended periods). What remains to be seen is if healthcare organizations can continue to provide the materials required for clinicians to maintain the excellent results achieved before the pandemic. Given the global supply chain failure, health care organizations face a “wicked” problem in continuing to prevent CLABSIs, a never event.

Our materials were either in short supply or defective, delaying appropriate care. Other complicating factors, especially in a pediatric setting, are finding tubing, sutures, dressings, and other materials that will adhere to small infants and large teenagers. Materials such as dressings needed to be modified to fit this specific patient population, which may introduce bacteria more easily. Some patients may also experience skin breakdown from sutures or a reaction to the chemicals used in the dressing change process, which can harbor bacteria if not treated properly.

Most of our new supplies or replacements to bridge the gap resulted in a learning curve for the staff. It took more time to perfect the usage of these materials, and yet still, some of the materials caused injuries to our patients' frail skin.

Adaptable solutions

Wicked problems require adaptable solutions (Periyakoil, 2007). Wicked problems are solved by involving stakeholders working at the unit level who are also enculturated in the organization. It is also important to identify champions willing to lead the effort.

To address the supply chain failure in the U.S. President Joseph Biden Jr. issued an Executive Order (EO) “On a Sustainable Public Health Supply Chain” (Exec. Order No. 14017, 86 Fed. Reg. 11849, 2021). In response, The Department of Health, and Human Services (HHS, 2022) convened a workgroup of 179 experts from industry and academia were given several charges. The workgroup's first charge was to create a “a diverse,

agile, public health supply chain and sustain long-term U.S. manufacturing capabilities for future pandemics” (2022, p. 10). The HHS published a report called the *National Strategy for a Resilient Public Health Supply Chain*, February 2022. The report was delivered one year after the EO, describes the progress made in strengthening the U.S. supply chain and industrial base. The HHS report also addresses how some of the goals were implemented and provides government officials with further direction. The report is thorough, continues to evolve, and, most importantly, addresses the need to hear the perceptions of the frontline staff working through the pandemic.

Innovative supply chain solutions are already emerging, such as using technologies like blockchain, analytics, and artificial intelligence to improve the global supply chain (Bhaskar et al., 2020). One proposed idea is for the buyer to connect directly with the supplier, whether located in the U.S. or internationally (Bhaskar et al., 2020). The current supply chain system requires a middleman, making the process competitive and untrustworthy due to a lack of transparency.

Additive manufacturing (3-D and 4-D printing) is already used in some industries, including healthcare (Linke, 2017). In recent years 3-D printers were developed to take digitally produced designs and print them out in layers using polymers, metals, powders, foams, etc. In 4-D printing, the products or parts created are “self-configuring (for example, using) biomaterials that would continue to evolve” (Linke, 2017, para 23). Children's Hospital Colorado (2022) is the first children's hospital to use 3-D printed casts for children with fractures, sprains, ligament injuries, and dislocations. The casts are use a kid-friendly material; it is lightweight, waterproof, and adjustable. The benefit of additive manufacturing is that it can create customizable products or parts delivered directly to the end-user, cutting out all the time and processes of the supply chain (Linke, 2017).

Healthcare organizations appear to be in the beginning stages of considering the global supply chain issue. What is important is for organizations not to become complacent and let this crisis go to waste. It is important for healthcare organizations to do a deep dive and hear the experiences of the nurses on the frontline and not assume that the only materials in short supply was personal protective equipment and ventilators.

For pediatric nurses, bargaining and trading supplies between units is not sustainable, but nurses know this. Pediatric nurses will do what they need to do to provide the best care possible to their patients. Imagine a system within an organization that permits the bedside nurse to view what supplies and equipment are available and where they are in the hospital. It would end units' hoarding supplies, and it may work for the entire system and benefit the patients. It is important for nurses to be at the table where decisions like these are suggested or decided.

Our unit made it through two years of the pandemic, with some lives lost to COVID- 19, but not as many as we had thought. Unfortunately, now we continue to watch helplessly as our patients succumb to what feels like our own shortcomings. Nurses have adapted to changes and limitations caused by other entities to keep patients alive. As nurses, it is our duty to provide optimal, safe patient care. We cannot do this without the collaboration of the healthcare organization, medical suppliers, and policymakers' so that we can climb out of this dangerous situation.

Nurses need to be a part of the discussion for all revisions made to supply chains. At the point of care, nurses are the key informants for what worked and did not throughout the pandemic. Nurses must continue to bring cases like this one forward so that healthcare organizations and political leaders understand the breadth and depth of the global supply chain failure. Unfortunately, the morbidity and mortality will continue until there are solutions to this wicked problem.

Summary

The failure of the global supply chain became rapidly apparent at the beginning of the COVID-19 pandemic when healthcare organizations were left without supplies needed to care for patients. The

supply chain failure is one downstream effect of the pandemic and indirectly impacts patient morbidity and mortality. CLABSIs are preventable hospital-acquired complications that falls within the healthcare provider's scope of practice to intervene and implement change. The prevalence of CLABSIs costs individuals their health and lives and hospital systems excessive money. Standardized central line insertion and care bundles have proven to be effective in reducing the incidence of CLABSI; however, they are dependent on the availability of materials and supplies. It remains to be seen if healthcare organizations can continue to provide the materials required for clinicians to maintain the excellent results that were achieved with never events before the pandemic. The failure of the global supply chain must be examined by healthcare organizations, manufacturers, and government officials so that new systems can be put into place, so we are prepared for a public health emergency. The failure of the global healthcare supply chain is a wicked problem that needs resolution soon for the health of all people.

References

- Bell, T., & O'Grady, N. P. (2017). Prevention of central line-associated bloodstream infections. *Infectious Disease Clinics of North America*, 31(3), 551–559. <https://doi.org/10.1016/j.idc.2017.05.007>.
- Bhaskar, S., Tan, J., Bogers, M. L. A. M., Minssen, T., Badaruddin, H., Israeli-Korn, S., & Chesbrough, H. (2020). At the epicenter of COVID-19—the tragic failure of the global supply chain for medical supplies. *Frontiers in Public Health*, 8. <https://doi.org/10.3389/fpubh.2020.562882>.
- Bloomberg (2021, September 21). How one Covid case upended Toyota's just-in-time supply chain. Retrieved 3/29/2022 <https://www.supplychainbrain.com/articles/33690-how-one-covid-case-upended-toyotas-just-in-time-supply-chain>.
- Centers for Disease Control and Prevention [CDC] (2020). Checklist for prevention of central line-associated bloodstream infection. <https://www.cdc.gov/hai/pdfs/bsi/checklist-for-clabsi.pdf>.
- Centers for Medicare & Medicaid Services [CMS] (2006). Eliminating serious, preventable, and costly medical errors—never events. <https://www.cms.gov/newsroom/factsheets/eliminating-serious-preventable-and-costly-medical-errors-never-events>.
- Centers for Medicare & Medicaid Services [CMS] (2008). Roadmap for implementing value driven healthcare in the traditional Medicare Fee-for-Service Program. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Quality-InitiativesGenInfo/downloads/vbroadmap_oea_1-16_508.pdf.
- Children's Hospital Colorado (2022). 3-D printed casts for broken bones and other injuries. <https://www.childrenscolorado.org/doctors-and-departments/departments/orthopedics/services/3d-printed-casts/>.
- Department of Health and Human Services. [HHS] (2022). National strategy for a resilient public health supply chain. <https://www.phe.gov/Preparedness/legal/Documents/National-Strategy-for-Resilient-Public-Health-Supply-Chain.pdf>.
- Exec. Order No. 14017, 86 Fed. Reg. 11849. <https://www.federalregister.gov/documents/2021/03/01/2021-04280/americas-supply-chains> (February 24, 2021).
- Gooch, K., & Gonzalez, G. (2021, November 2). Supply chain issues are here to stay: Health leaders share predictions, strategies. *Becker's Hospital Review*. <https://www.beckershospitalreview.com/hospital-management-administration/supply-chain-issues-are-here-to-stay-health-leaders-share-predictions-strategies.html>.
- Ista, E., van der Hoven, B., Kornelisse, R. F., van der Starre, C., Vos, M. C., Boersma, E., & Helder, O. K. (2016). Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: A systematic review and meta-analysis. *The Lancet Infectious Diseases*, 16(6), 724–734. [https://doi.org/10.1016/S1473-3099\(15\)00409-0](https://doi.org/10.1016/S1473-3099(15)00409-0).
- Linke, R. (2017, December). *Additive manufacturing explained*. MIT Sloane School of Management. <https://mitsloan.mit.edu/ideas-made-to-matter/additive-manufacturing-explained>.
- NEJM Group (2018, April). What is lean healthcare? *The New England Journal of Medicine (NEJM) Catalyst*. <https://catalyst.nejm.org/doi/full/10.1056/CAT.18.0193>.
- Periyakoil, V. S. (2007). Taming wicked problems in modern health care systems. *Journal of Palliative Medicine*, 10(3). <https://doi.org/10.1089/jpm.2007.9955>.
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155–169. <https://doi.org/10.1007/BF01405730>.
- United Nations Children Fund [UNICEF] (2022, March). *Child mortality and COVID-19*. UNICEF Data. <https://data.unicef.org/topic/child-survival/covid-19/>.
- Virginia Mason Production Management System [VMPS] (2010). VMPS FAQs. Retrieved 3/26/2022 from <https://createvalue.org/wp-content/uploads/2013/11/case-study-virginia-mason.pdf>.