

Quality improvement program in medication administration through nasogastric tube

Programa de melhoria da qualidade na administração de medicamentos via sonda nasoenteral
Programa de mejora de la calidad en la administración de medicamentos por sonda nasoenteral

Laís Facioli Rosa Moreno da Costa¹  <https://orcid.org/0000-0001-5459-4957>

Carlos Alberto Grespan Bonacim²  <https://orcid.org/0000-0003-0347-9419>

Rosana Aparecida Pereira¹  <https://orcid.org/0000-0001-9389-3300>

Jennifer Midiani Gonella¹  <https://orcid.org/0000-0002-3162-6327>

Jacinthe Leclerc³  <https://orcid.org/0000-0001-5261-2648>

Fernanda Raphael Escobar Gimenes¹  <https://orcid.org/0000-0002-5174-112X>

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Corresponding author

Fernanda Raphael Escobar Gimenes
E-mail: fregimenes@eerp.usp.br

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Camila Takao Lopes
(<https://orcid.org/0000-0002-6243-6497>)
Escola Paulista de Enfermagem, Universidade Federal de São Paulo, SP, Brazil

Abstract

Objective: Evaluate the impact of a quality improvement program related to the frequency indicators of obstructed nasogastric tubes, the time the nursing team spent on oral medication preparation and administration through this route, and the costs associated with the incident.

Method: Intervention study aimed at comparing pre (Phase I) and post (Phase II) implementation of a Quality Improvement Program, proposed by *Institute for Healthcare Improvement*. Ninety-two medication doses were observed in Phase I and 66 doses in Phase II. Four *Plan-Do-Study-Act* (PDSA) cycles were needed to achieve the proposed target for the improvement program.

Results: The average time the professional spent on solid medication preparation and administration through nasogastric tube decreased in both phases. Frequencies of obstructed tubes dropped from 33.3% (Phase I) to 7.4% (Phase II) and no probe was obstructed during cycles 1, 2, and 4. The average cost of the obstruction per patient was R\$ 1,251.05 per month in Phase I and R\$ 23.31 in Phase II. After testing the changes, time savings for the nursing team and cost savings for the institution were verified.

Conclusion: The PDSA cycles were effective in reducing non-conformities in medication preparation and administration via nasogastric tube. This improvement influenced the obstruction frequency, related costs, and the average time the nursing professional spent on the preparation and administration of the medication doses.

Resumo

Objetivo: Avaliar o impacto de um programa de melhoria da qualidade relacionado aos indicadores de frequência de sondas nasoenterais obstruídas, do tempo despendido pela equipe de enfermagem no preparo e na administração de medicamentos orais por essa via, e dos custos associados ao incidente.

Método: Estudo de intervenção voltado para a comparação pré (Fase I) e pós (Fase II) implementação de um Programa Melhoria da Qualidade, proposto pelo *Institute for Healthcare Improvement*. Foram observadas 92 doses de medicamentos na Fase I e 66 doses na Fase II. Foram necessários quatro ciclos *Plan-Do-Study-Act* (PDSA) para atingir a meta proposta para o programa de melhoria.

Resultados: Houve redução no tempo médio gasto pelo profissional no preparo e na administração de medicamentos sólidos via sonda nasoenteral em ambas as fases. As frequências de sondas obstruídas reduziram de 33,3% (Fase I) para 7,4% (Fase II) e nenhuma sonda apresentou-se obstruída durante os ciclos 1, 2 e 4. O custo médio da obstrução por paciente foi de R\$ 1.251,05 ao mês na Fase I e de R\$ 23,31 na Fase II. Após as mudanças testadas, foi verificada economia de tempo para a equipe de enfermagem e de custo para a instituição.

¹Ribeirão Preto College of Nursing, University of São Paulo, Ribeirão Preto, SP, Brazil.

²Faculty of Economics, Administration and Accounting, University of São Paulo, Ribeirão Preto, SP, Brazil.

³Université du Québec à Trois-Rivières, Université Laval, Trois-Rivières, Québec, Canada.

Conflicts of interest: none to declare.

Conclusão: Os ciclos PDSA foram eficazes na redução de não conformidades no preparo e na administração de medicamentos via sonda nasoenteral. Tal melhoria impactou a frequência de obstrução, os custos relacionados e o tempo médio gasto pelo profissional de enfermagem durante o preparo e a administração das doses.

Resumen

Objetivo: Evaluar el impacto de un programa de mejora de la calidad relacionado con los indicadores de frecuencia de sondas nasoenterales obstruidas, del tiempo invertido por el equipo de enfermería en la preparación y en la administración de medicamentos orales por esa vía y de los costos asociados con el incidente.

Métodos: Estudio de intervención direccionado para la comparación previa (Fase I) y posterior (Fase II) a la implementación de un Programa Mejora de la Calidad, propuesto por el *Institute for Healthcare Improvement*. Se observaron 92 dosis de medicamentos en la Fase I y 66 dosis en la Fase II. Se necesitaron cuatro ciclos *Plan-Do-Study-Act* (PDSA) para alcanzar la meta propuesta para el programa de mejora.

Resultados: Hubo reducción del tiempo promedio consumido por el profesional en la preparación y en la administración de medicamentos sólidos por sonda nasoenteral en ambas fases. La frecuencia de la obstrucción de las sondas se redujo del 33,3 % (Fase I) para el 7,4 % (Fase II) y ninguna sonda presentó obstrucción durante los ciclos 1, 2 y 4. El costo promedio de la obstrucción por paciente fue de R\$ 1.251,05 al mes en la Fase I y de R\$ 23,31 en la Fase II. Después de someter a pruebas los cambios, se verificó un ahorro de tiempo para el equipo de enfermería y de costo para la institución.

Conclusión: Los ciclos PDSA fueron eficaces en la reducción de no conformidades en la preparación y en la administración de medicamentos por sonda nasoenteral. Esa mejora impactó la frecuencia de obstrucción, los costos relacionados y el tiempo promedio consumido por el profesional de enfermería durante la preparación y la administración de las dosis.

Introduction

Obstruction is one of the most common incidents in patients using a nasogastric tube, and the incorrect reconstitution of solid drugs, failure to flush the tube before and after administration of the drug(s), and enteral diets are factors that contribute to this incident.⁽¹⁾

In a study conducted in Brazilian hospitals, the researchers identified that nasogastric tube obstruction occurred in 36.5% of administrations and that the incident was associated with errors in oral medication preparation and administration.⁽²⁾ In addition, a study conducted in an Iranian intensive care unit (ICU) revealed that medication preparation and administration errors were observed in 24% and 25.3% of all incidents identified in patients using a nasogastric tube.⁽³⁾

The mere implementation of protocols may not solve the problem, as other factors can contribute to the errors. Hence, to understand the multiple factors, methods are needed that were elaborated to perceive all probable causes.⁽⁴⁾ Among these methods, the *Institute for Healthcare Improvement's* (IHI) collaborative quality improvement approach stands out. This model involves three fundamental questions that are combined with *Plan-Do-Study-Act* (PDSA) cycles to plan actions and achieve measurable improvements: 1) What are we trying to accomplish? 2) How can one know if the change

has resulted in improvement? 3) What change can result in improvement?⁽⁵⁾

It is highlighted that nursing teams can determine existing problems in processes and systems that affect the quality of care. They are also able to devise effective solutions because they are at the forefront of health care.⁽⁶⁾ Therefore, the objective of this research was to evaluate the impact of a quality improvement program related to the frequency indicators of obstructed nasogastric tubes, the time the nursing team spent on oral medication preparation and administration through this route, and the costs associated with the incident.

Methods

An intervention study was conducted in a medical clinic ward of a medium-sized general hospital in the interior of the state of São Paulo, Brazil, for comparison pre (Phase I) and post-implementation (Phase II) of a quality improvement program.

The sample consisted of a total of 158 doses prepared and administered via nasogastric tube, 92 doses in Phase I (baseline), and 66 doses in Phase II. Between March and April 2019, the nursing professionals responsible for the oral medication preparation and administration through nasogastric tube undertook direct observation.

For this study, the following improvement measures were selected: outcome, process, and balance.

Outcome measures

The frequency of obstructed tubes and the cost of the obstructions were monitored in Phases I and II. To collect data on the obstructions, a form was prepared containing the following information: patient name, date and time of obstruction, actions necessary to remove the obstruction, and the result of actions (whether the tube was cleared or not). The patient's medical record was accessed to obtain evidence of obstructions (need to change the tube, examination, and x-ray report to verify the positioning of the tube after a new insertion procedure and materials used for the insertion of the new tube). The incident reports (focusing on obstructions), carried out by the nursing team and monitored by the institution's Patient Safety Center, were also analyzed. To calculate the cost of obstructions, the following variables were considered: average time spent by the nurse to insert the new nasogastric tube into the patient, labor cost related to the insertion procedure of the tube, and cost of hospital materials used in the insertion procedure of the tube. The average time spent by the nurse during blind insertion of the tube at the bedside was calculated for seven procedures performed by two different nurses. The time was measured in seconds and with the help of a clock, from the moment the professional entered the patient's room until his departure.

Process measures

For the preparation of the solid drug, the following frequencies were monitored: handwashing before and after preparation; disinfection of mortar and pestle before preparation; more than one drug prepared in the same container; correctly prepared solid drug and correctly reconstituted solid drugs. For the administration of oral medication: tubes tested before administration of the medication; drugs administered separately; tubes flushed with at least 15 ml of filtered water before medication administration; tubes flushed with at least 10 ml of filtered water between one medication and the other; tubes flushed with 15 to 30 ml of filtered

water after the end of the medication, and handwashing after medication administration. Data were collected with the help of an electronic form, developed by the researcher, and face and content validated by five experts; a practical step-by-step guide was elaborated for the medication and administration techniques through nasogastric tube. Direct observation of the nursing team was also performed during the medication preparation and administration through a tube.

Balance measures

The time two distinct nursing technicians spent during the medication preparation and administration through nasogastric tube was calculated. The time was measured in seconds and with the help of a clock, from the moment the professional washed hands for the preparation until the handwashing after the medication administration. PDSA cycles were performed to reduce errors in the preparation and administration of oral medications via nasogastric tube between August and November 2019. The following changes were tested: implementation of the guide of good practices in the preparation and administration of oral medication via tube; provision, at the nursing station, of the step-by-step preparation and administration of oral drugs via tube; provision of a list of drugs that cannot be crushed; training of the nursing staff; replacement of aluminum mortar and pestle for porcelain and standardization of the use of a 20-ml syringe in sterile and individualized packaging.

PDSA Cycle 1

The quality improvement team gradually implemented the changes over four months. PDSA cycle 1 was conducted between 08/20/2019 and 08/23/2019 and involved training of three nursing professionals, which occurred through a dialogue-based presentation of the medication preparation and administration techniques and dynamics with images to memorize the step-by-step of both techniques. During this period, 14 doses of oral drugs were observed during preparation and administration in three patients using a tube.

PDSA Cycle 2

PDSA cycle 2 was performed between 09/16/2019 and 09/20/2019; it involved the training of two nursing professionals and 14 doses of oral drugs were observed during preparation and administration in three patients with a tube. The following changes were tested: the step-by-Step preparation and administration guide for oral drugs via nasogastric tube was made available at the nursing station, as well as a list of drugs that cannot be crushed, for consultation during the preparation of doses. Two nursing professionals were trained and observed concerning the execution of the techniques to maintain the 50% reduction of non-conformities in both processes.

PDSA Cycle 3

The goal of this cycle was to expand the training to all nursing professionals in the medical clinic, totaling 18 professionals. It also aimed to reduce the frequency of errors in the preparation and administration of solid drugs via tube by 50%. This cycle took place between 09/25/2019 and 10/01/2019 and 18 doses of solid drugs were observed during preparation and administration via tube, by nine nursing professionals, in five patients. During this cycle, the following changes were tested: standardization of the use of the 20-ml syringe in sterile and individualized packaging for the preparation of oral medications, replacement of aluminum mortar and pestle, and acquisition of two units of porcelain mortar and pestle for the medical clinic.

PDSA Cycle 4

PDSA cycle 4 occurred in the period from 11/01/2019 to 11/08/2019 and involved the observation of 20 doses of oral drugs prepared and administered by six nursing professionals in three patients using a tube. The objective was to verify if the improvement was maintained after 30 days of training of the entire nursing team. The data was entered on the online platform *Survey Monkey*[®] and transferred to Microsoft Excel spreadsheets[®], where the descriptive analyses were performed. To estimate the cost related to the obstruction, the direct costing method⁽⁷⁾ and the “*bottom-up*” typology

were used for greater detail and rigor in the evaluation of the attributable cost components.⁽⁸⁾ Thus, the estimation of the intervention (or change) effects respects the essential aspect to establish a cost function: cause and effect relationship⁽⁸⁾ between the cost driver and the resulting costs, in the case between the direct cost of Phase I and Phase II, as resulting from the quality improvement project.

Approval for the study was obtained from the Research Ethics Committee of the University of São Paulo at Ribeirão Preto College of Nursing (CAAE: 91976318.6.0000.5393). The study participants signed the Informed Consent Form and were informed that the results of the research were intended for publication, with guaranteed secrecy and anonymity.

Results

In Phase I, 92 doses of drugs were observed and procedures were performed correctly in only 3.3% of the direct observations. The most frequent errors identified during preparation were: hands not washed before preparation (71; 77.2%); mortar and pestle not disinfected with soap water or 70% alcohol before preparation (69; 75%); wrongly reconstituted solid drug (69; 75%); more than one medication mixed in the same container (46; 50%) and hands not washed after medication preparation (83; 90.2%). The most frequent errors identified during oral medication administration were: tube placement not tested before administration (87; 94.6%); tube not flushed with at least 15 ml of filtered or sterile water before administration (86; 93.5%); drugs not administered separately (46; 50%); tube not flushed with at least 10 ml of filtered or sterile water between one medication and another (61; 66.3%) and hands not washed after medication administration (70; 76.1%).

In Phase II, 66 medication doses were observed and improvements were identified in the following process measures: hands not washed before preparation (6; 9.0%); mortar and pestle not disinfected with soap water or 70% alcohol before preparation (11; 1.6%); incorrectly reconstituted solid medica-

tion (0; 0%); more than one medication mixed in the same container (0; 0%) and hands not washed after preparation (24; 36.3%).

The process measures related to medication administration improved as well: tube positioning not tested before the medication administration (6; 9.0%); tube not flushed with at least 15 ml of filtered or sterile water before medication administration (10; 15.1%); drug not administered separately (0; 0%); tube not flushed with at least 10 ml of filtered or sterile water between one drug and another (0; 0%) and hands not washed after medication administration (20; 18.1%).

The following chart (Figure 1) shows the behavior of the process measures monitored over time. The results are displayed as percentages, according to the observation period, i.e. Phase I (baseline) and Phase II (PDSA cycles 1, 2, 3, and 4). As observed, the error frequencies during the oral medication preparation and administration processes through nasogastric tubes decreased over time.

Concerning the analysis of the cost of the nasogastric tube insertion, the time the nursing professional spent during the insertion of the tube, the average labor cost, cost of hospital materials, and cost of tube obstruction were considered in Phase I and II (Tables 1 and 2).

Phase I was performed during thirty days, when three patients presented tube obstruction, and the average cost of obstruction per patient was R\$ 1,251.05 per month. One of the patients presented three obstructions, which required tube replacement. Due to the difficulty of inserting the new nasogastric tube blindly at the bedside, the procedure had to be performed by endoscopy. During one of the endoscopy procedures, however, the patient presented a loss of oxygen saturation and required hospitalization in an intensive care unit (ICU).

Phase II was performed during three months, when only two patients had obstructed tubes, and the average cost of obstruction per patient was R\$ 23.31 per month. In addition to the five obstructions verified in Phase I (Table 1), which required a new insertion procedure, according to evidence in the medical record, five others were identified, which the nursing team was able to reverse through the use of cold water, lukewarm water and/or simethicone. In Phase II, during cycles 1, 2, and 4, no tube obstruction was verified. In the third PDSA cycle (phase II), there were two obstructions requiring tube replacement and the cost was also calculated, according to Table 2.

The frequency of tube obstruction also decreased, from 33.3% in Phase I to 7.4% in Phase II, considering the number of patients with tube obstruction and the duration of each study phase. To calculate the cost

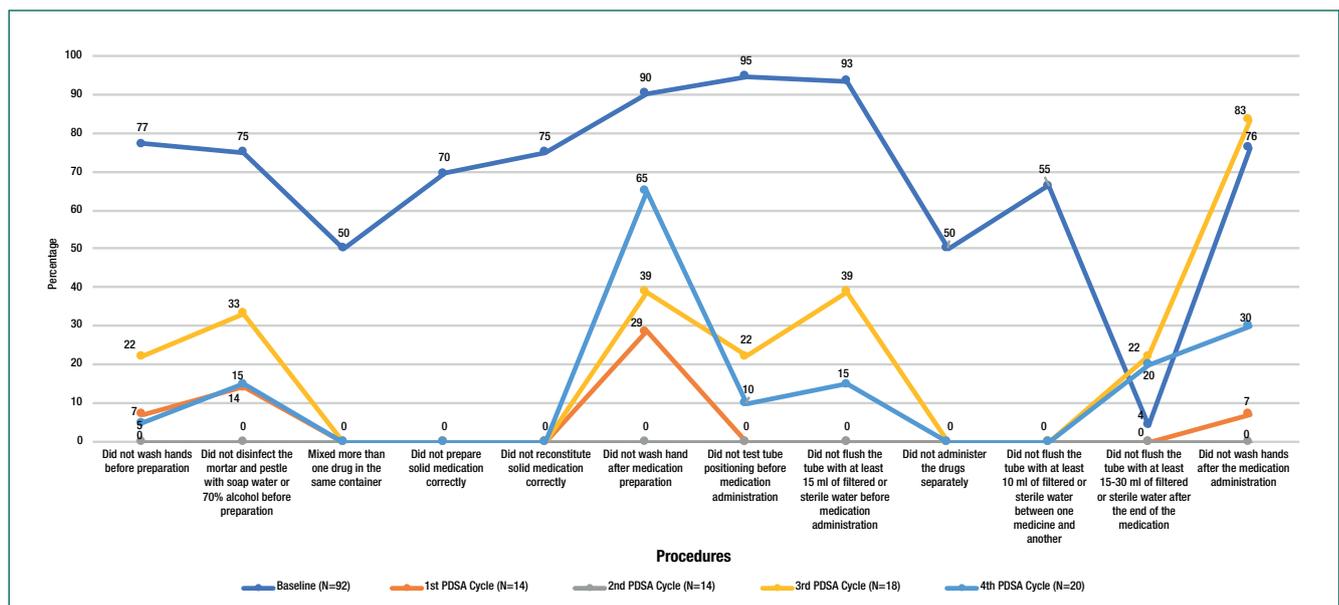


Figure 1. Trend chart of process measures monitored over time

Table 1. Costs related to nasogastric tube obstruction during hospitalization, in Phase I

Material	Unit value (in Reais)	Patient 1	Patient 2	Patient 3	Total
Tube fixation device	4.64	3	1	1	5
Gastric tube	30.21	3	1	1	5
20-ml syringe	0.46	0	0	1	1
0.9% Sodium Chloride	1.21	0	0	1	1
Procedure gloves (pair)	0.27	3	1	1	5
Sterile gauze	0.22	3	1	1	5
Tube insertion	12.60	0	0	1	1
Abdominal x-ray	20.34	0	0	1	1
Endoscopy	640.46	3	1	0	4
Daily rate adult ICU	980.00	1	0	0	1
Value per patient		R\$ 3,007.40	R\$ 675.80	R\$ 69.95	R\$ 3,753.15
Average per patient		-	-	-	R\$ 1,251.05

Source: Data from Billing sector of the Institution, 2019.

Table 2. Costs related to nasogastric tube obstruction during hospitalization, in Phase II

Material	Unit value (in Reais)	Patient 1	Patient 2	Total
Tube fixation device	4.64	1	1	2
Gastric tube	30.21	1	1	2
20-ml syringe	0.46	1	1	2
0.9% Sodium Chloride	1.21	1	1	2
Procedure gloves (pair)	0.27	1	1	2
Sterile gauze	0.22	1	1	2
Tube insertion	12.60	1	1	2
Abdominal x-ray	20.34	1	1	2
Value per patient		R\$ 69.95	R\$ 69.95	R\$ 139.90
Average per patient		-	-	R\$ 69.95

Source: Data from Billing sector of the Institution, 2019.

of inserting the nasogastric tube, the time the professional spent on inserting the tube was considered. The mean time to perform the procedure was 20 minutes. Considering the professional’s workload, charges, salary, and the time spent to perform the tube insertion procedure, the procedure cost the institution R\$12.60. When comparing the time the nursing technician spent to prepare and administer solid medication via nasogastric tube in both phases, more time was verified in Phase I, that is, 2 minutes and 48 seconds, versus 1 minute and 34 seconds in Phase II. The costs of both procedures was also calculated, including all expenses and values in Phase I and Phase II, which corresponded to R\$1.03 and R\$ 0.33, respectively. Hence, it was verified that, after the changes tested in the PDSA cycles, in addition to time savings for the nursing team, the cost for the institution dropped.

Discussion

The external generalization of this improvement program’s effectiveness needs to be demonstrated

in future research. In this study, the time the nursing team spent to clear the tube was not calculated for the sake of further cost analysis. This variable should be considered in future studies.

In this study, errors were appointed in the preparation and reconstitution of the solid drug. Lack of standardization and knowledge of the team about the technique were detected during data collection. The mixture of more than one medication in the same container was verified in 50% of the prepared doses. Research conducted in three Brazilian hospitals showed that the most common incident in oral medication preparation was the mixing of tablets with other medication (43.5%).⁽²⁾ Evidence also suggested that 91% of the nurses often mix solid drugs in the same container during dose preparation⁽⁹⁾ and the professionals’ low knowledge level contributes to the likelihood of errors relating to this technique.^(10,11)

In this study, the medication administration process through nasogastric tube also presented non-conformities: the tube positioning test was not performed, the tubes were not flushed before

the medication administration, the tube was not flushed between one medication and another, the drugs were not administered separately. Similar results were observed in a study conducted in three Brazilian public hospitals. According to the authors, in 67.6% of the administered doses, the professional did not test the tube position; in 65.6% of the observations, the drugs were administered together and, in 86.5%, the tube was not flushed between one drug and another.⁽²⁾ In another study conducted in a hospital in the state of Paraná, the results showed that only 42% of the health professionals flushed the tube before, between, and after the administration of the drug and only 9% of the team mentioned the importance of this action after the end of the administration.⁽¹¹⁾

The non-conformity in the oral medication preparation and administration through nasogastric tube contributed to the tube obstruction events identified in this study. This incident was also common in earlier studies.^(1,2,12) According to the researchers, the obstruction rates varied from 12% to 45% and resulted in worse outcomes for the patients, as the incident contributed to delays in enteral diet administration and increased costs for the health institutions.⁽¹³⁾

In this study, the frequency of obstructions decreased over time (from 33.3% in Phase I to 7.4% in Phase II). This result can be related to the changes implemented in the processes, which included training of the entire nursing team. In a study conducted in two Dutch hospitals, after the implementation of PSDA cycles, there was a reduction in the rate of tube obstruction, as well as a significant reduction in administration errors.⁽¹⁴⁾

In another study, however, the researchers evaluated the influence of the use of different agents on the clearing of gastric probes, including sterile water, baking soda, papain, digestive enzymes, cola-based soda, orange juice, and pineapple juice.⁽¹⁵⁾ According to the researchers, the test results revealed that some of these products significantly changed the inner surface of the tube and that this degradation may be harmful to patients and should not be used in clinical practice.⁽¹⁵⁾ Therefore, flushing the probe with at least 30 ml of water during the con-

tinuous infusion of enteral diet in adult patients; flushing the tube with at least 30 ml of water after checking the residual gastric volume; flushing the tube before and after administration of medication and enteral diets and between the administration of one drug and another, are other important preventive measures to keep the tubes permeable and free from obstructions. In addition, available evidence has shown that drinking or sterile water is the preferred fluid to flush the tubes, reconstitute or dilute enteral formulae and medicines.⁽¹⁶⁾

In this study, the nursing team used cold water, lukewarm water and simethicone to clear the tubes. According to the *Handbook of Drug Administration via Enteral Feeding Tubes*,⁽¹⁷⁾ tubes should be cleared with 15 to 30 ml of cold or lukewarm water. The first option for clearing the tube is flushing with lukewarm water in gentle back and forth movements, and the second option is the use of pancreatic enzyme solution.⁽¹⁸⁾

The changes in the oral drug preparation and administration processes through nasogastric tubes influenced the time the nursing technician spent preparing and administer solid drugs (average time 2m 48s in Phase I and 1m 29s in Phase II). In addition, they also influenced the direct costs of obstruction per patient also impacted (average cost R\$ 1,251.05 in Phase I and R\$ 23.31 in Phase II).

Considering that obstructions are preventable incidents, the results of this study demonstrate that the non-conformities observed in oral medication preparation and administration through nasogastric tubes can result in waste, which are actions that do not add value to the product or service, but that generate unnecessary costs and expenses for institutions,⁽¹⁹⁾ in addition to worsening the patient outcomes.

Conclusion

As verified, the collaborative quality improvement approach, based on PSDA cycles, contributed to the reduction of most non-conformities observed in oral medication preparation and administration through nasogastric tubes. Those changes affected

the mean time nursing professionals spend on medication dose preparation and administration, the frequency of tube obstruction, and the costs related to this important safety incident.

Collaborations

Costa LFRM, Bonacim CAG, Pereira RA, Gonella JM, Leclerc J, and Gimenes FRE contributed to the study design, analysis, and interpretation of the data, writing of the article, relevant critical review of the intellectual content, and approval of the final version for publication.

References

- Rocha AJ, Oliveira AT, Cabral NA, Gomes RS, Guimarães TA, Rodrigues WB, et al. Causas de nutrição enteral em unidades de terapia intensiva. *Rev Pesq Saúde*. 2017;18(1):49-53.
- Gimenes FR, Pareira RA, Horak AC, Oliveira CC, Reis AM, da Silva P, et al. Medication incidents related to feeding tube: a cross-sectional study. *African J Pharm Pharmacol*. 2017;11(27):305-13.
- Sohrevardi SM, Jarahzadeh MH, Mirzaei E, Mirjalili M, Tafti AD, Heydari B. Medication Errors in Patients with Enteral Feeding Tubes in the Intensive Care Unit. *J Res Pharm Pract*. 2017;6(2):100-5.
- Organização Mundial da Saúde (OMS). Guia curricular de segurança do paciente da Organização Mundial da Saúde: edição multiprofissional. Rio de Janeiro: OMS; 2016 [citado 2020 Set 25]. Disponível em: <http://apps.who.int/iris/bitstream/10665/44641/32/9788555268502-por.pdf>
- Langley G, Moen R, Nolan K, Nolan T, Norman C, Provost L. *The Improvement guide: a practical approach to enhancing organizational performance*. 2nd ed. San Francisco (CA): Jossey-Bass Publishers; 2009.
- Easter K, Tamburri LM. Understanding patient safety and quality outcome data. *Crit Care Nurse*. 2018;38(6):58-66.
- Collier SA, Stockman LJ, Hicks LA, Garrison LE, Zhou FJ, Beach MJ. Direct healthcare costs of selected diseases primarily or partially transmitted by water. *Epidemiol Infect*. 2012;140(11):2003-13.
- Tan SS, Bakker J, Hoogendoorn ME, Kapila A, Martin J, Pezzi A, et al. Direct cost analysis of intensive care unit stay in four European countries: applying a standardized costing methodology. *Value Health*. 2012;15(1):81-6.
- Heydrich J, Heineck I, Bueno D. Observation of preparation and administration of drugs by nursing assistants in patients with enteral feeding tube. *Braz J Pharm Sci*. 2009;45(1):117-20.
- Souza MR, Contarine LM, Barreto JB, Santos CM, Bertoza VP. Obstrução do cateter de nutrição enteral e a administração de fármacos sólidos na unidade de terapia intensiva adulto. *Rev Persp Biol Saúde*. 2018;8(26):42-53.
- Godoi KE, Penteado ST, Mendes AE, Andrzejewski VM. Medicamentos via sonda: perfil prático em um hospital terciário de ensino. *Rev Bras Farm*. 2016;7(3)13-18.
- Pereira RA, Souza FB, Rigobello MC, Pereira JR, Costa LR, Gimenes FR. Quality improvement programme reduces errors in oral medication preparation and administration through feeding tubes. *BMJ Open Quality*. 2020;9:e000882.
- Guerrero Márquez G, Martínez Serrano A, Gutiérrez Juárez M, García Lozano A, Mayordomo Casado B, Torrijos Rodríguez MI, et al. Effectiveness of an educational intervention to improve nurses' knowledge on pediatric nasogastric intubation. *Arch Argent Pediatr*. 2018;116(6):402-8.
- van den Bemt PM, Cusell MB, Overbeeke PW, Trommelen M, van Dooren D, Ophorst WR, et al. Quality improvement of oral medication administration in patients with enteral feeding tubes. *Qual Saf Health Care*. 2006;15(1):44-7.
- Rucart PA, Boyer-Grand A, Sautou-Miranda V, Bouteloup C, Chopineau J. Influence of unclogging agents on the surface state of enteral feeding tubes. *JPEN J Parenter Enteral Nutr*. 2011;35(2):255-63.
- Boullata AM, Boullata JL. Pancreatic enzymes prepared in bicarbonate solution for administration through enteral feeding tubes. *Am J Health Syst Pharm*. 2015;72(14):1210-4.
- White R, Bradnam V. *Handbook of drug administration via enteral feeding tubes*. 3th ed. London: Pharmaceutical Press; 2015.
- Boullata JL, Carrera AL, Harvey L, Escuro AA, Hudson L, Mays A, McGinnis C, Wessel JJ, Bajpai S, Beebe ML, Kinn TJ, Klang MG, Lord L, Martin K, Pompeii-Wolfe C, Sullivan J, Wood A, Malone A, Guenter P; ASPEN Safe Practices for Enteral Nutrition Therapy Task Force, American Society for Parenteral and Enteral Nutrition. ASPEN Safe Practices for Enteral Nutrition Therapy [Formula: see text]. *JPEN J Parenter Enteral Nutr*. 2017;41(1):15-103.
- Peimbert-García RE, Matis T, Beltran-Godoy JH, Garay-Rondero CL, Vicencio-Ortiz JC, López-Soto D. Assessing the state of lean and six sigma practices in healthcare in Mexico. *Leadersh Health Serv (Brad Engl)*. 2019;32(4):644-62.