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DEVELOPMENT OF A NASOENTERAL TUBE SECURING DEVICE FOLLOWING AN INTERPROFESSIONAL APPROACH: A TECHNOLOGICAL INNOVATION REPORT

DESENVOLVIMENTO DE DISPOSITIVO PARA FIXAÇÃO DE SONDA NASOENTERAL COM ABORDAGEM INTERPROFISSIONAL: RELATO DE INOVAÇÃO TECNOLÓGICA

DESARROLLO DE UN DISPOSITIVO PARA FIJAR SONDAS NASOENTERALES SIGUIENDO UN ENFOQUE MULTIPROFESIONAL: REPORTE DE INNOVACIÓN TECNOLÓGICA

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RESUMO

Objetivo: Relatar o desenvolvimento de um dispositivo para fixação de sonda nasoenteral. **Métodos:** Trata-se de um relato de inovação tecnológica realizado entre setembro e dezembro de 2024, durante uma Maratona de Empreendedorismo, conforme 11 etapas de design de produtos para a saúde. O protótipo foi produzido em ácido polilático e submetido a teste exploratório em um boneco anatômico de silicone. Avaliaram-se, por observação direta, aderência, estabilidade da sonda, resposta à tração manual gradual, integridade estrutural e permanência da fixação durante 72 horas, sob mudanças de orientação e ação da gravidade. **Resultados:** Foram geradas sete alternativas, das quais uma foi selecionada e refinada. No modelo simulado, o protótipo permaneceu aderido e manteve a sonda posicionada por 72 horas, sem desprendimento completo, deslocamento visualmente perceptível ou dano estrutural nas condições avaliadas. A tração manual gradual não ocasionou liberação imediata da sonda. As avaliações foram qualitativas, sem dinamômetro, repetição padronizada ou teste em seres humanos. **Conclusão:** O estudo desenvolveu um protótipo funcional de fixador de sonda nasoenteral por modelagem tridimensional e impressão em ácido polilático. Documentou-se o processo de concepção e teste simulado.
Descritores: Empreendedorismo; Tecnologia Biomédica; Intubação Gastrointestinal; Enfermagem; Nutrição Enteral.

ABSTRACT

Objective: To report the development process for a nasoenteral tube securing device. **Methods:** A technological innovation report study conducted between September and December 2024 during and Entrepreneurship Marathon, according to the 11 stages for the design of health products. The prototype was made with polylactic acid and subjected to an exploratory test on a realistic silicone doll. The following aspects were evaluated by means of direct observation: adherence, tube stability, response to gradual manual traction, structural integrity and securement for 72 hours under different orientations and action of gravity. **Results:** Seven alternatives were constructed, selecting and refining one of them. The prototype remained adhered to the simulated model and kept the tube in position for 72 hours, presenting no full detachment, visually perceptible displacement or structural damage in the conditions evaluated. Gradual manual traction did not produce immediate tube release. The assessments were qualitative, without resorting to a dynamometer, standardized repetition or tests in human beings. **Conclusion:** The study developed a functional prototype for a nasoenteral tube securing device by means of tridimensional modeling and printing on polylactic acid. The conception and simulated test process was documented.
Descriptors: Entrepreneurship; Biomedical Technology; Gastrointestinal Intubation; Nursing; Enteral Nutrition.

RESUMEN

Objetivo: Reportar el desarrollo de un dispositivo diseñado para fijar sondas nasoenterales. **Métodos:** Reporte de innovación tecnológica realizado entre septiembre y diciembre de 2024 durante una Maratón de Capacidad Emprendedora conforme a las 11 etapas de diseño de productos para la salud. El prototipo se diseñó en ácido poliláctico y fue sometido a una prueba exploratoria sobre una muñeca realista de silicona. Se evaluó lo siguiente por medio de observación directa: adherencia, estabilidad de la sonda, respuesta a la tracción manual gradual, integridad estructural y permanencia de la fijación durante 72 horas, con cambios en materia de orientación y acción de la gravedad. **Resultados:** Se generaron siete alternativas, seleccionando y refinando una de ellas. El prototipo permaneció adherido al modelo simulado y mantuvo la sonda en su posición durante 72 horas, sin desprenderse por completo, desplazamiento a simple vista o daños estructurales en las condiciones evaluadas. Aplicar tracción manual gradualmente no hizo que la sonda se desacoplara de inmediato. Las evaluaciones fueron cualitativas y no se usó ningún dinamómetro ni repetición estandarizada o pruebas en seres humanos. **Conclusión:** El estudio permitió desarrollar un prototipo funcional de un dispositivo de fijación para sondas nasoenterales por medio de modelado tridimensional e impresión en ácido poliláctico. Se documentó el proceso de diseño y prueba simulada.
Descriptores: Emprendimiento; Tecnología Biomédica; Intubación Gastrointestinal; Enfermería; Nutrición Enteral.

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What is already known:

- Improper nasoenteral tube securement is associated with displacements, nutritional therapy interruptions and device-related injuries.
- Adhesive securement methods present variable performance in terms of adherence, tube displacement and skin integrity.
- When choosing and assessing securing devices, measurable technical criteria should be considered before attempting any clinical application.

What this article adds:

- It describes how 11 design stages for health products were applied in the interprofessional development of a nasoenteral tube securing device.
- It presents operational criteria for performing an exploratory test of the prototype on a realistic silicone model.
- It records securement for 72 hours in the simulated conditions and warns that this result does not demonstrate safety, comfort or clinical efficacy.

INTRODUCTION

Technological innovation in the health area has played a central role in improving the care provided and solving complex problems faced by health professionals and patients alike. Public policies in Brazil have fostered research and development in terms of innovating technologies, integrating scientific and technical knowledge in a search for solutions that create value for the health sector[1-2].

Involving areas such as Nursing and Nutrition, interprofessionality has proved to be essential to identify and solve health assistance problems. In particular, Nursing has stood out in the technological innovation field resorting to its clinical experience to devise solutions centered on the patients' needs[3-4]. Complementarily, nutritionists play a fundamental role in managing enteral nutritional therapies, seeking comfort and safety for patients in addition to efficacy. Problems related to nasoenteral tube (NET) securement are a concern for Nursing and Nutrition professionals alike, considering the clinical outcomes involved and the quality of the care offered[5].

Improper NET securement represents a significant challenge in the clinical context. Traditional securement methods such as micropore tapes or improvised glues frequently result in negative outcomes such as accidental traction, aesthetic discomfort and need for frequent exchanges due to displacement caused by moisture, oiliness and secretions[2]. In addition to that, an increasing concern is the risk for medical device-associated pressure injuries. The incidence of these lesions in hospitalized adult patients can reach 62.4%. However, for the incidence of pressure injuries specifically related to nasogastric and nasoenteral tubes, that rate is 44.1%, with improper tube securement as main reason[3].

These injuries not only exert negative impacts on patients' comfort and well-being but also increase the need for frequent dressing changes, resulting in Nursing teams having to devote more time to these care actions, in pain for the patients and in worse assistance-related indicators such as incidence of care-related adverse events. Such failures impair patient safety, make their experience worse and generate additional costs for the system, with global impacts in the assistance provided[2-3].

In this scenario, entrepreneurship has consolidated itself as a strategic approach to turn clinical challenges into innovation opportunities. Entrepreneurship marathons are intensive and collaborative events that gather multiprofessional teams and mentors to devise solutions in a brief period of time[6-7]. Associated with design processes, tridimensional printing allows converting digital models into physical prototypes by means of layer-by-layer deposition, favoring fast cycles in terms of creation, analysis and adjustment of products targeted at clinical requirements[8-9].

The objective of this study is to report the development process for a nasoenteral tube securing device.

METHOD

A technological innovation report study intended to document the process followed to develop a nasoenteral tube securing device. The 11 stages for designing health products proposed by Stein et al.[8] were adopted, namely: 1) Briefing; 2) Data survey; 3) Analysis of the problem; 4) Concept; 5) Generation of alternatives; 6) Selection of the best alternative; 7) Solution refinement; 8) Prototyping; 9) Tests; 10) Modifications; and 11) Implementation.

The activity took place between September and December 2024, in the context of a university entrepreneurship marathon. The interprofessional team consisted of three members: a nurse, a nutritionist and a physical therapist. Three nurses with due experience in using and handling nasoenteral tubes also offered specific technical contributions to the development process.

Stages of the process[8]

Briefing

In the Briefing stage, observations arising from the care practice and team discussions delimited the project problem: adherence loss in traditional methods, tube displacement or traction possibility, need for securing device exchanges and significant visibility of the adhesive material on the face.

The clinical experience of the members from the Nursing and Nutrition areas was turned into baseline requirements of the project. These requirements included mechanical stability on the simulated model, fit to the face region, simple access to the tube for handling purposes, small visible area and production possibility by means of fast prototyping.

A challenge was defined based on this briefing: developing a compact securing device that would meet all the requirements identified and that could be reproduced by means of tridimensional modeling and printing. The patients' safety, comfort and experience were considered clinical purposes to be researched in specific studies, not as outcomes evaluated in this stage.

Data survey

A narrative literature survey was conducted to detect securement technologies and methods described in it and identify problems associated with adherence, displacement and skin integrity. In parallel, free conversations of a technical-consultative nature were developed with three nurses experienced in handling nasoenteral tubes. The team organized all recurrent aspects as project requirements: stability, anatomical fit, handling ease, resistance to moisture and lower visual area occupied by the securing device.

These conversations did not follow any structured script or questionnaire; they were also not recorded or used to collect personal or professional data. No transcriptions, individual characterization, quotes or analyses of testimonies were implemented as empirical materials; the contributions had an exclusively technical function while designing the product.

Analysis of the problem

The analysis combined three sources: problems observed in the practice, literature materials on tube-related events and technical requirements pointed out in the queries. Detachment due to moisture or oiliness was prioritized as failure mechanisms, as well as improper securing device position, tube displacement and need for repeated handling.

An exploratory, non-systematic survey of solutions described in studies and disclosed in electronic catalogues accessible in the Brazilian market was also conducted. Securement methods with adhesive or micropore tapes and industrialized stabilization devices were identified. The analysis compared the retention principles, the application modalities, the possibility to access the tubes and the securing device visible area. No multicenter assessment of products used in institutions was conducted; the survey also does not allow asserting non-existence of similar solutions. The intended project differential was to integrate retention, access to tubes, compact format and production by means of tridimensional printing.

Concept

The three terms-concepts (safety, aesthetics and functionality) were chosen by consensus among the team members, as they synthesize the requirements surveyed. Safety was considered as the stability project requirement to be tested, without representing any clinical results; aesthetics referred to reducing the visual area occupied by the securing device; and functionality was concerned with tube handling and retention. The term "Fixe" corresponds to the name assigned to the company initiative created during the Entrepreneurship Marathon and derives from the verb "*fixar*" in Portuguese ("secure" in English), directly conveying the purpose of the product.

Generation of alternatives and selection of the best option

The intuitive "brainstorming" method described in the framework adopted[8] was employed. The three members presented format and mechanism possibilities without restrictions, initially without evaluating the ideas; subsequently, the proposals were discussed and turned into seven digital sketches by means of modeling software compatible with Ender-3 V3 (Creality©) printers[9]. The selection process was by consensus, considering anatomical fit to the face model, tube retention, ease to open and close the mechanism, small visible area, printing simplicity and industrial refinement viability. No quantitative scores were used in this selection.

Solution refinement and prototyping

The alternative selected was refined with the support of an industrial design company. The prototypes were printed in polylactic acid (PLA), the thermoplastic chosen for the prototyping phase due to its availability, rigidity and fast re-production possibility. The decision to choose PLA did not correspond to the definite material for clinical use, whose biocompatibility was not assessed in this study.

The refinement process was carried out in iterative cycles consisting in digital modeling, printing, visual inspection, prototype handling by the team on the realistic doll, recording the problems noticed and returning all the information to the design company for further geometrical adjustments and reprinting. The clinical demands were translated into verifiable requirements in the model: tube fit, seal maintenance, access for placing and removing the device, fit to the face area and piece integrity after handling. In this stage, the term "user" referred to the professional who would handle the securing device; no patients took part in the evaluation and their preferences and comfort were not assessed.

Some dimensional and structural details pertaining to the device were kept confidential due to the industrial property protection process filed at the National Industrial Property Institute. This restriction was maintained without omitting the methodological stages, the selection criteria or the overall test procedures required to understand the development process.

Tests on a simulated model and implementation

The exploratory test was performed on a realistic silicone doll. The prototype was attached to the face region using the surgical glue foreseen for the solution, and a nasoenteral tube was placed in the retention mechanism. The entire set was observed during 72 hours and repositioned front-way and side-ways, in order to vary gravitational force directions. Head movements were simulated manually during repositioning.

The following aspects were evaluated: a) adherence, defined by sustained contact between the base and the silicone surface with no full detachment; b) stability, verified by absence of visually perceptible tube detachment; c) response to traction, observed after applying manual and gradual force, without using a dynamometer; d) structural integrity, defined by absence of cracks, deformation or failures in the mechanism; e) dwelling, corresponding to sustained securement for up to 72 hours; and f) handling, verified by the possibility of introducing, securing and removing the tube. The results were recorded in a descriptive way.

A micropore tape strip was applied, but it was only used as an exploratory visual reference, with no standardization, repetition or statistical analysis. The implementation stage included documenting the design, initiating the process to safeguard the intellectual property and structuring the Fixe company.

Ethical aspects

No research procedures were conducted on human beings in this study. The professional contributions described corresponded to informal technical queries, without constituting any sample, collecting any personally identifiable information or using testimonies as research data. Consequently, submission to the CEP/Conep System was waived in this technological development stage. The device was also not tested on people.

RESULTS

Development of the product

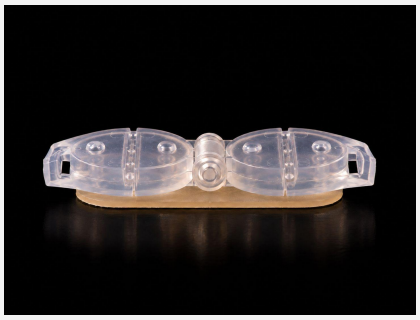
Of the seven alternatives generated, one setup was selected and subjected to the refinement cycles. The result was an articulated prototype digitally modeled and printed on PLA, with a mechanism devoted to receiving and retaining the tube. Figures 1, 2 and 3 show different views of the prototype developed.

Figure 1 – Illustration showing the nasoenteral tube securing device developed by Fixe



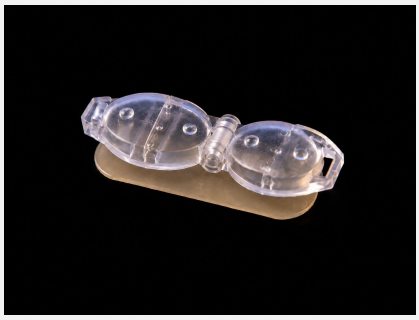
Source: Research data, 2026.

Figure 2 – Illustration showing the nasoenteral tube securing device developed by Fixe



Source: Research data, 2026.

Figure 3 – Illustration showing the nasoenteral tube securing device developed by Fixe



Source: Research data, 2026.

Initial validation

The prototype was installed on the silicone doll without visible ruptures or deformation in the piece. The device remained adhered to the face region and kept the tube inside the retention mechanism during the 72-hour period observed.

The criteria were evaluated individually. As for adherence, the base had not fully detached at the end of the 72 hours. In relation to stability, no visually perceptible tube displacement was identified while changing the doll's orientation and the action of gravity. In the gradual manual traction test, the tube was not immediately released from the mechanism; however, the force applied was not quantified. The piece remained with no visible cracks or deformations, meeting the structural integrity criterion. The team managed to introduce, secure and remove the tube, which met the handling descriptive criterion.

In the exploratory observation with micropore tape, qualitative difference in terms of adherence and occupied visual area were perceived. As the procedure was not standardized, repeated or measured, superiority of the prototype in relation to traditional methods was not established. None of the assessments allows reaching conclusions regarding clinical efficacy, skin integrity, safety or comfort in human beings.

Potential impact

In addition to the physical prototype, the process resulted in modeling files, documentation to safeguard the industrial design and structuring of the Fixe company. These products characterize the innovation implementation phase but do not constitute proof of clinical performance or commercial viability.

DISCUSSION

This study achieved its objective by reporting the development process for a nasoenteral tube securement prototype and explaining the conception, refinement and simulated test stages. Securement resisting for 72 hours, absence of visually perceptible displacement and piece integrity only show baseline functional viability on the model used. Not having measured force, implemented standardized repetitions or evaluated the prototype on people preclude interpreting these results as efficacy, safety and clinical comfort.

The problem that drove this development is consistent with the literature[10-11]. A number of reviews on adverse events related to nasogastric and nasoenteral tubes describe displacement, unplanned removal, obstruction, improper position and respiratory harms, with repercussions in enteral therapy continuity[4,12-13]. Studies conducted with hospitalized adults also indicate that there can be traction and other mechanical complications throughout a tube use period, which would require new interventions by the team[5,14]. These findings support the relevance of researching tube securement; however, they do not allow attributing the reduction in these events to the prototype.

In the specific field of securement, Thorpe et al.[3] compared methods on an *ex vivo* model and detected differences in terms of adherence, displacement and skin integrity between the techniques evaluated. Some care guidelines also highlight the need to stabilize the tube and systematically inspect the contact area to prevent device-related injuries[15-16]. When compared to these studies, the current report adds a design alternative, but it employs less controlled assessments and does not examine the skin; it is for these reasons that its results should be understood as exploratory.

The iterative process used is coherent with the bridge-gapping process between the Nursing and Design areas proposed by Stein et al.[8], where practice problems are turned into requirements, alternatives and progressively refined prototypes. Tridimensional printing favors this path because it allows for fast production of susceptible geometries and physical inspection before clinical stages[9]. However, technological innovation in health demands critical assessments regarding benefits, risks, use conditions and repercussions in care and not merely producing a technically new device[16].

Creating the Fixe company and organizing the industrial property represent a strategy for translating the academic project into productive development. Some studies on entrepreneurship in the Health and Nursing areas describe this movement as a possibility to expand professional performance and structure responses to assistance-related problems[10-11,14-15,17]. However, protection of the intellectual property and structuring of the company do not substitute technical, regulatory and clinical assessments; their role in this report is limited to demonstrating organizational continuity of the development process[14].

The main contribution made by this study is methodological and technological in nature: documenting how a problem arising from the assistance scope was turned into seven alternatives, one physical prototype and baseline test criteria. Having explicitly described the brainstorming, the refinement cycles and the operational definitions of adherence, stability, traction, integrity, dwelling and handling enhanced transparency of the process and offered parameters for more controlled pre-clinical assessments. The conclusions remain restricted to the simulated model used.

IMPLICATIONS FOR THE PRACTICE

The results do not authorize immediate clinical use of the prototype or changing nasoenteral tube securement protocols. In this phase, the implication for the practice consists in identifying technical requirements and criteria that can inform the evaluation of securement solutions.

For Nursing and Nutrition, the report shows a structured way of turning difficulties observed in the care practice into product specifications and test procedures. Interprofessional participation contributed to combining tube handling needs, enteral therapy continuity and prototyping viability; however, this does not represent validation with users.

Before any attempt at incorporating the technology to the assistance scope, the device requires standardized bench trials, defining the material for clinical use, biocompatibility assessments, regulatory analysis and ethically approved studies with human beings. Until this evidence exists, no claims regarding reduction in number of injuries, accidental traction, Nursing time, safety or comfort are supported by the results of this study.

STUDY LIMITATIONS

The research was limited to the development and qualitative observation of a prototype on a single realistic silicone doll. The number of iterations was not defined; temperature, moisture and oiliness were not controlled; displacement was not objectively measured; no dynamometer was used to quantify traction; and securement degradation was not assessed at standardized intervals. Silicone does not reproduce human skin variability, sweating, secretions, spontaneous movements or anatomical differences found in real-life assistance.

The micropore tape was only used as an exploratory reference with no comparison protocol, which precludes making inferences regarding superiority. The market survey was not systematic or multicenter. No patient took part in the study and the professionals were not formally assessed as users; therefore, comfort, acceptability, clinical usability, skin integrity, safety and impact on the assistance provided were not measured. The secrecy related to industrial property also restricted presenting structural dimensions and details. These limitations circumscribe the findings to baseline functional viability on a simulated model.

CONCLUSION

The study developed a functional prototype for a nasoenteral tube securing device by means of a structured interprofessional process, tridimensional modeling and printing on PLA. The prototype remained adhered to the realistic silicone doll, kept the tube in position and maintained its structural integrity for 72 hours in the qualitative conditions evaluated. The contribution of this paper lies in having produced the prototype and systematized the initial test stages and criteria. As no quantitative trials were conducted and no human beings took part in the study, the results do not demonstrate clinical efficacy, safety or comfort of the device.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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All authors are responsible for the textual writing and critical review of the intellectual content, the final version published, and all ethical, legal, and scientific aspects related to the accuracy and integrity of the study.

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