

# NURSING MANAGEMENT IN THE CONTROL OF AVOIDABLE LOSSES OF IMMUNOBIOLOGICAL PREPARATIONS

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**ABSTRACT:** Immunobiological preparations are thermolabile, requiring refrigeration from the production laboratory until their administration. This study aimed to quantify and identify the causes of avoidable losses of immunobiological preparations in Paraná state, for the period 2009 to 2012. This was a quantitative, retrospective, exploratory study, in which data were obtained using the database of the Information System for the Calculation of Immunobiological Preparations Used of Paraná. Total losses of immunobiological preparations due to avoidable causes were 3,437,552 doses, with 95% of the losses being vaccines of the basic vaccination program. Failures that occurred in the organization of the service and/or the nursing work process can be identified, as the losses were considered preventable. The nurse is the manager of immunization activities, therefore, it is imperative to update this professional through training and continuing education for an effective service in the control of vaccine-preventable diseases.

**KEYWORDS:** Nursing; Vaccines; Refrigeration.

## GERENCIAMENTO DE ENFERMAGEM NO CONTROLE DE PERDAS EVITÁVEIS DE IMUNOBIOLOGICOS

**RESUMO:** Os imunobiológicos são termolábeis, mantidos sob refrigeração desde o laboratório produtor até a sua administração. Este estudo teve como objetivos levantar o número e identificar as causas de perdas evitáveis de imunobiológicos no estado do Paraná, no período de 2009 a 2012. É um estudo exploratório retrospectivo quantitativo, cujos dados foram obtidos na base de dados do Sistema de Informação de Apuração de Imunobiológicos Utilizados do Paraná. O total das perdas de imunobiológicos por causas evitáveis foram de 3.437.552 doses, sendo que 95% das perdas foram vacinas do calendário básico de vacinação. Pode-se identificar que ocorreram falhas na organização do serviço e/ou no processo de trabalho da enfermagem, por se tratar de perdas consideradas como evitáveis. O enfermeiro é o gerenciador das atividades de imunização, sendo imprescindível a atualização deste profissional, através de capacitações e educação continuada para um serviço eficaz no controle das doenças imunopreveníveis.

**DESCRITORES:** Enfermagem; Vacinas; Refrigeração.

## ADMINISTRACIÓN DE ENFERMERÍA EN EL CONTROL DE PÉRDIDAS EVITABLES DE INMUNOBIOLOGICOS

**RESUMEN:** Los inmunobiológicos son termolables y se quedan bajo refrigeración desde el laboratorio productor hasta su administración. Este estudio tuvo como objetivos investigar el número e identificar las causas de pérdidas evitables de inmunobiológicos en el estado de Paraná, en el periodo de 2009 a 2012. Es un estudio exploratorio retrospectivo cuantitativo, cuyos datos fueron obtenidos en la base de datos del Sistema de Información de Apuración de Inmunobiológicos Utilizados de Paraná. El total de las pérdidas de inmunobiológicos por causas evitable fueron de 3.437.552 dosis, siendo 95% de las pérdidas de vacunas del calendario básico de vacunación. Se puede identificar que hubo fallas en la organización del servicio y/o en el proceso de trabajo de enfermería, ya que son pérdidas consideradas evitables. El enfermero es el administrador de las actividades de inmunización, siendo imprescindible la actualización de este profesional, por medio de capacitaciones y educación continuada para un servicio eficaz en el control de las enfermedades inmunoprevenibles.

**DESCRIPTORES:** Enfermería; Vacunas; Refrigeración.

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## INTRODUCTION

The National Immunization Program (NIP) was established by the Ministry of Health in 1973 with the purpose of coordinating immunization actions, using basic vaccination strategies developed in a hierarchical and decentralized manner, contributing to the control, elimination and/or eradication of vaccine-preventable diseases<sup>(1)</sup>.

The Cold Chain is the process of storage, preservation, manipulation, distribution and transport of immunobiological preparations. The NIP ensures adequate refrigeration conditions, from the production laboratory to the moment that the product is administered<sup>(1)</sup>.

Vaccines currently represent the most cost-effective intervention strategy applied in public health, with their epidemiological impact being fundamental in the reduction and control of vaccine-preventable diseases<sup>(2)</sup>. The increasing use of immunobiological preparations highlights the need to ensure the quality of these products.

As products of biological origin, immunobiological preparations comprise immunizing agents such as vaccines and homologous and heterologous sera. These are thermolabile products, that is, when exposed to inappropriate temperatures they undergo inactivation of their immunogenic components, compromising their power and efficiency, as heat accelerates the inactivation of these components. Accordingly, immunobiological preparations must be kept refrigerated at all times, as defined by the production laboratory<sup>(3)</sup>.

The NIP has several Information Systems that allow monitoring, analysis and evaluation of the Cold Chains of the entire country, including the inventory, distribution, and doses applied, as well as the loss of immunobiological preparations, whether these are technical losses or physical losses, which ensures a diagnosis for the organization and planning of future distributions<sup>(4)</sup>.

The control of losses is analyzed using the Calculation of Immunobiological Preparations Used Information System (SI-AIU), classifying the types of losses. Physical losses, considered avoidable, are given the following classification: broken flask - flasks or ampoules of an immunobiological preparation that are broken; power outage - immunobiological preparation

spoiled due to exposure to inadequate temperature because of interruption in the electricity supply; equipment failure - occurrence of mechanical failure in the refrigeration equipment; expired validity - the expiry of the validity deadline stated on the product label; inadequate procedure - immunobiological preparation loss arising from errors in standardized technical procedures; transportation failure - failure during transport; other reasons - immunobiological preparation lost due to any other reason not previously mentioned<sup>(4)</sup>.

In 2011, the NIP published a systematic evaluation, conducted using the SI-AIU, with four states of Brazil in 2008, of the main causes of vaccine losses and the financial cost associated with these losses. The results showed that two states presented 38% of physical losses classified as "power outages". The other two states presented 39% of physical losses due to "other reasons", which suggests a possible registry error in the system since it does not detail this type of occurrence. When the financial cost generated by the losses of the four states was evaluated, this was close to R\$ 8 million, which could be used in the acquisition of new immunobiological preparations<sup>(5)</sup>, and in actions of the program.

For the NIP to achieve its main objective, the reduction of vaccine-preventable illnesses, in addition to the adherence of the population, it is fundamental to guarantee the quality of the immunobiological preparations offered, including their conservation, with the adequate functioning of the Cold Chain. Nursing professionals are more involved in this area, as they exercise both administrative and care activities. They are responsible for the immunization actions, and they must ensure the conservation process of immunobiological preparations, being considered suitable for such activity through laws governing the nursing practice<sup>(6-7)</sup>.

However, the nursing teams are involved with many administrative actions, which may explain the occurrence of failures in adhering to the recommendations for the conservation of immunobiological preparations, which could compromise their immunogenic characteristics, causing the loss of the product<sup>(6)</sup>.

Studies conducted in Brazil on nursing practice in the conservation of vaccines show that many nursing professionals working in this area

ignore basic standards, such as the appropriate temperature for the preservation of vaccines in health units, or even, regarding the validity period of the immunobiological preparations after opening the bottle<sup>(6)</sup>. This reinforces the importance of the ongoing education of these professionals, since this information is contained in the cold chain manuals provided by the NIP.

Given the above and considering that the nursing professional is responsible for the immunization actions, from conservation to the administration of the vaccines, it is important to know the causes of avoidable losses of immunobiological preparations, both for the analysis of the work in this area and to support the management of the cold chain, seeking to minimize vaccine losses.

This study aimed to identify the causes of and quantify avoidable losses of immunobiological preparations in the state of Paraná, in the period 2009 to 2012.

## METHOD

This was an exploratory, retrospective, and quantitative study. This type of study aims to provide greater familiarity with the problem, in order to make it more explicit and refine underexplored ideas. Its planning is very flexible, so that it allows the consideration of various aspects related to the fact studied<sup>(8)</sup>.

The state of Paraná is administratively divided into 22 Health Regions (HRs) covering 399 municipalities, with all HRs having a cold chain, which provide immunobiological preparations for the municipalities within their areas of coverage. Likewise, each municipality has a cold chain, which distributes biopharmaceuticals to the

Health Units within its area of coverage<sup>(9-10)</sup>.

The data for this study were obtained in the SI-AIU of the state of Paraná. The Movement of Immunobiological Preparations reports, between the years 2009 to 2012, were selected from the 22 Regional cold chains, 399 Municipal cold chains, and also from the vaccine centers.

All immunobiological preparations that appeared in the SI-IAU of the state of Paraná were included, i.e., vaccines and homologous and heterologous sera diluents, distributed by the NIP.

Data collection was conducted between the months of January and February 2013, and for this an instrument was constructed as an Excel spreadsheet which enabled the organization and analysis of the data. A request for access to the database was authorized by the State Immunization Coordination of the Health Secretariat of Paraná State.

## RESULTS

The data obtained show that in Paraná the losses of immunobiological preparations due to preventable causes were 3,437,552 doses in the period from 2009 to 2012. The year that stood out was 2011, with 38% of all doses lost during this period.

Of the total losses, 1.5% of the doses were due to Broken Flasks (BF); 7% due to Power Outages (PO); 9% due to Equipment Failure (EF); 76.5% due to Expired Validity (EV); 2% due to Inappropriate Procedure (IP); 0.4% due to Transportation Failure (TF); and 4% of the doses for Other Reasons (OR), as presented in Table 1.

A breakdown of preventable vaccine losses of the basic vaccination program (Table 2), with the special immunobiological preparations being

Table 1 - Breakdown of total losses of immunobiological preparations, for the period 2009 to 2012. Paraná, 2013

Year	QF	FE	FEq	VV	PI	FT	Others	Total
2009	4.508	48.170	31.525	410.842	9.294	4.217	33.683	542.239
2010	6.033	64.660	62.363	520.226	8.575	1.783	24.659	688.299
2011	35.342	76.705	131.786	972.584	27.830	7.419	60.093	1.311.759
2012	6.899	41.506	73.247	727.791	12.001	1.079	32.732	895.255
Total	52.782	231.041	298.921	2.631.443	57.700	14.498	151.167	3.437.552

Key: BF - Broken Flask; PO - Power outage; EF - Equipment failure; EV - Expired Validity; IP - Inappropriate Procedure; TF - Transportation Failure; OR - Other Reasons

Source: SI-AIU/PNI/MS - PR.

analyzed separately (Table 3).

The immunobiological preparations that showed the most incidents were vaccines of the basic vaccination program, routinely administered by the healthcare services, representing 3,273,861 (95.2%) doses.

The losses due to Expired Validity are highlighted, as this was the cause of the loss of 2,489,337 (76%) doses of these vaccines. Followed by losses due to refrigeration Equipment Failure, with 292,472 (8.9%) doses lost. Power outages accounted for 227,048 (6.9%) of these doses lost. The losses due to Other Reasons were significant, with 144,002 (4.4%) doses. Inappropriate Procedures accounted for the loss of 56,273 (1.7%) doses. Broken Flasks also appeared, with the avoidable loss of 51,087 (1.6%)

doses, and Transport Failure with 13,642 (0.4%) lost doses.

According to Table 3, the special immunobiological preparations accounted for 163,691 (4.8%) of the total number of lost doses and, as with the routine vaccinations, the main cause was Expired Validity, representing 142,106 (86.8%) doses. The second major cause of loss was due to Other Reasons with 7,165 (4.4%) doses. Equipment failure appeared with a loss of 6,449 (3.9%) doses. A total of 3,993 (2.4%) doses were lost due to Power Outages. The loss of special immunobiological preparations due to Broken Flasks was 1,695 (1.0%) doses. Inadequate Procedures accounted for 1,427 (0.9%) lost doses and Transport Failures for 856 (0.5%) doses.

Table 2 - Breakdown of losses of vaccines of the basic vaccination program, for the period 2009 to 2012. Paraná, 2013

Vaccine	QF	FE	FEq	VV	PI	FT	Others	Total
Triple Bact. (DTP)	1.911	12.160	19.590	308.320	2.690	540	10.680	355.891
Hepatitis B (HB)	3.570	18.634	29.075	232.676	4.875	2360	11.975	303.165
Yellow fever (YF)	1.345	41.510	39.075	452.690	7.045	1535	15.545	558.745
BCG	4.680	14.800	28.980	208.080	4.730	450	10.520	272.240
Inactivated polio (Salk)	210	781	415	3.667	121	30	608	5.832
Triple viral (MMR)	3.424	27.663	23.549	101.400	4.039	1461	17.061	178.597
Adult double (dT)	3.030	19.968	41.655	375.901	4.630	580	16.555	462.319
Attenuated polio (Sabin)	28.895	51.985	59.020	378.200	17.275	5280	45.230	585.885
Double viral (MR)	430	10.180	3.890	193.530	370	90	1.341	209.831
Rabies - Vero cell	674	1.791	1.867	8.120	580	150	1.060	14.242
Tetavalent (DTP+Hib)	1.455	12.886	24.393	41.784	4.124	593	7.160	92.385
Meningoencephalitis	317	6.296	4.166	1.272	823	92	1.264	14.230
Pentavalent DT-P+Hib+HB	38	286	207	12.393	85	06	33	13.048
Human Rotavirus (LARV)	641	3.939	8.717	170.876	3.748	333	3.291	191.545
10-val. Pneumo. (PCV 10)	467	4.169	7.873	428	1.138	152	1.679	15.906
Total	51.087	227.048	292.472	2.489.337	56.273	13.642	144.002	3.273.861

Source: SI-AIU/NIP/MS - PR.

Table 3 - Breakdown of losses of special immunobiological preparations, 2009 to 2012. Paraná, 2013

Immunobiological preparation	QF	FE	FEq	VV	PI	FT	Others	Total
Tetanus immunog.	3	14	15	1.573	7	0	2.401	4.013
Tetanus serum	91	119	31	1.406	21	0	45	1.713
Arachnid antivenom	44	29	61	734	12	0	15	895
Scorpion antivenom	19	57	21	696	9	0	10	812
Elapid antivenom	8	5	0	429	5	0	10	457
Anti-rabies serum	118	69	87	1.080	42	1	129	1.526
Bothropic antivenom	104	108	119	6.293	25	6	148	6.803
Anti-diphtheria serum	3	0	0	187	0	0	0	190
Bothropic/Crotalic antivenom.	4	10	2	94	0	0	7	117
Crotalic antivenom	51	84	101	1.580	14	0	37	1.867
Haemophilus inf. B	5	1	15	1.498	0	5	17	1.541
Anti-varicella immunog.	0	0	0	159	0	0	5	164
Anti-hep. B immunog.	5	14	7	1.282	2	5	21	1.336
23-val. pneumococcal	6	136	168	2.905	27	11	85	3.338
Anti-rabies immunog.	0	0	8	377	0	10	17	412
Typhoid fever	10	0	0	121	11	0	6	148
Loxosceles antivenom	1	5	18	642	14	0	12	692
Lonomia antivenom	0	5	10	682	0	0	0	697
Influenza	709	2.824	2.023	60.104	645	610	3.405	70.320
Acellular DTP	2	3	6	272	0	1	5	289
Varicella	25	47	126	538	19	7	4	766
Hepatitis A	3	6	14	109	0	0	7	139
Anti-botulism serum	15	10	40	305	145	0	230	745
7-val. pneumococcal	9	170	61	91	15	0	31	377
Influenza H1N1	460	277	3.516	58.949	414	200	518	64.334
Total	1.695	3.993	6.449	142.106	1.427	856	7.165	163.691

Source: SI-AIU/NIP/MS - PR.

## DISCUSSION

To facilitate the comprehension of the findings, the reasons for the loss of vaccines of the basic schedule will be analyzed first, as shown in Table 2, followed by the reasons for the loss of special vaccines, according to Table 3.

The losses due to Expired Validity stand out, corresponding to 76% of all losses of routine vaccines, and the immunobiological preparation that presented this occurrence more was the yellow fever vaccine with 452,690 doses, and the oral polio vaccine (OPV) with 378,200 doses.

It was evidenced that, considering all reasons, the oral polio vaccine presented the highest number of lost doses compared with the other routine immunobiological preparations, including due to Broken Flasks. In 2011 Paraná received the vaccine from the GlaxoSmithKline (GSK) laboratory in glass flasks<sup>(11)</sup>, which resulted in a large number of operational broken flasks.

The optimization and supply of vaccines must be constantly reinforced, particularly when there is a batch close to the expiry date, which can be verified when organizing the refrigerator after cleaning, which is recommended every fortnight, and in the preparation of the monthly immunobiological preparations inventory report<sup>(1)</sup>. This activity is the responsibility of the nursing team, who should question the routine of services of the Health Units in order to reduce avoidable losses, which is consistent with the results of studies that indicate difficulties in maintaining organization in the refrigerator, including: inadequate infrastructure, insufficient or no professional training, and high turnover of professionals working in the vaccination room<sup>(12)</sup>.

Refrigeration Equipment Failure was the second biggest cause of loss of vaccines of the basic vaccination program. This type of loss can be reduced by performing preventive and corrective maintenance of the refrigerator, replacing the old household type equipment, with refrigerators specifically for the storage of immunobiological preparations<sup>(13)</sup>. Daily monitoring of the refrigerator temperature is also a way to evaluate whether the equipment is presenting problems<sup>(1)</sup>. This kind of occurrence can lead to large oscillations in temperature, which may compromise the immunogenicity of

the vaccines, since live attenuated virus vaccines are sensitive to higher temperatures ( $> 8^{\circ}\text{C}$ ), and the inactivated virus and bacterial vaccines sensitive to lower temperatures ( $< 2^{\circ}\text{C}$ )<sup>(10)</sup>.

Power Outage was also evidenced. When power outages occur, the recommendation of the NIP is that the refrigerator be kept closed and the internal temperature monitored rigorously, using a maximum and minimum thermometer, for up to two hours. When the power does not return, the team must prepare cool boxes with ice packs for a possible transfer of the immunobiological preparations from the refrigerator to ensure they do not undergo temperature change. In some cases, the immunobiological preparation should be moved to another Cold Chain (another unit or office)<sup>(1)</sup>, until the problem has been resolved.

As the household type refrigerator does not meet the safety and quality criteria regarding temperature stability, they must be replaced by refrigerated containers especially designed for this purpose. These containers, when compared to domestic refrigerators, maintain the recommended temperature for a longer period in the event of a power outage, providing the service with more time to perform the appropriate action<sup>(1-10)</sup>.

When analyzed the losses of special biopharmaceuticals it was observed that they presented significant losses due to Expired Validity, corresponding to 87%, with the influenza vaccine presenting the highest occurrence for this reason, with 60,104 (36.7%) lost doses, compared to the other special immunobiological preparations.

Losses related to the oral polio and influenza vaccines, are probably due to the annual vaccination campaigns, where there is a greater quantity of immunobiological preparations available in the health service to meet the target public, and the events may have coincided with this period. Another possible cause of loss can be associated with not achieving the vaccination coverage, that is, a request for more doses than necessary, resulting in a stock of vaccines that could reach their expiry date before use. Since this is a seasonal demand (the campaign period), this product requires a different control to the permanent products<sup>(13)</sup>, i.e., only maintaining sufficient quantities to cover the estimated vaccination population within that period.

Losses due to Other Reasons were also highlighted, representing 7,165 (4.4%) doses. Losses due to other reasons are not detailed in the information systems and can be due to unlabeled vials, making it impossible to identify the product, lyophilized preparations without diluents (without replacement possibilities), changes in color, presence of foreign bodies, and thefts. However, a high number of these losses was observed, when, mainly due to strict quality control, this should be "insignificant". This number is in line with this factor, suggesting flaws in the records in the SI-AIU.

The occurrence of Equipment Failure also resulted in the loss of special immunobiological preparations, accounting for 6,449 (3.9%) lost doses. This evidence reinforces the need to maintain a preventive and corrective maintenance contract that is up to date and renewed in advance, avoiding periods without cover<sup>(1)</sup>.

It is understood that Broken Flasks can be avoided with the organization of the service, as appropriate packaging can facilitate handling of the refrigerated flasks, without accidents occurring<sup>(1)</sup>. Evaluation studies applied in the vaccination room have often observed a lack of internal organization of the refrigerator, which may contribute to the breaking of the flasks of these vaccines<sup>(14)</sup>.

Another cause of loss is related to Inadequate Procedures, i.e., errors in standard technical procedures. This standardization is found in the cold chain manuals<sup>(1)</sup> and vaccination standard manuals<sup>(3)</sup>, which are provided by the NIP to all health units. Studies in Brazil identify that the conduct of the vaccination room staff still leaves much to be desired<sup>(10)</sup>, thus, the importance can be perceived of the training contained in the manuals, in addition to the supervision and monitoring of the process, as there is a need to further reduce these losses, seen in the results as the third lowest cause of loss of routine immunobiological preparations, and the second lowest with respect to the special immunobiological preparations.

Regarding all the losses identified, the lowest cause was Transportation Failure. These failures are comprised by reasons such as forgetting boxes of immunobiological preparations in the vehicle, traffic accidents, and detours causing longer journeys, among others. Those responsible

for this activity are the drivers of the municipal health departments, which, due to their function, probably do not receive specific training related to the transportation and conservation of immunobiological preparations.

It is noteworthy that the vaccines of the basic vaccination program presented a higher number of lost doses when compared to the special immunobiological preparations. It is understood that due to the fact that in the health service the amount of routine vaccines available to supply the entire population is much larger than the special vaccines, which are available for administration in the health services when there is a medical request, i.e., when there is a special indication for their use or in emergency situations, such as the use of immunoglobulins and the heterologous sera.

The results obtained from this study are worrying. The losses of immunobiological preparations due to preventable causes reflect the organization of the health service, in which the nurse is responsible for management.

The immunobiological preparations are high cost products for public health and their loss represents not only a financial loss, but may mean a shortage to supply the population and maintain control over vaccine-preventable diseases.

## FINAL CONSIDERATIONS

The scope and dynamism of the Immunization Program require constant updates for the professionals responsible for the cold chain of the immunobiological preparations. Each year, new vaccines are introduced into the vaccination schedule, with the management of these immunobiological preparations requiring full attention.

The study shows that in Paraná and in the majority of the other states, the nurse is the primary professional involved in the immunobiological preparations cold chain, and that the organization of the service and the nursing work process are directly related to the factors responsible for the loss of immunobiological preparations due to preventable causes. Therefore, it is believed that the continuing education of the professionals involved has a great potential to bring about the changes needed, primarily to assure the quality

of immunobiological preparations available and to reduce avoidable losses.

This study shows the reasons why immunobiological preparations were lost. The results may support nurses in the appropriate management of the immunobiological preparations cold chain, seeking to minimize the avoidable losses of vaccines.

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