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Pharmaco-Economic Study of the Preparation and Sterilization of Surgical Compresses and Dressings at HMIMV

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Abstract | **Original Research Article**

Sterile compresses occupy a very important place in the hospital setting, particularly in operating rooms. They are necessary for performing any surgical procedure, regardless of its nature, and they are obligatorily used for cleaning and disinfecting surgical wounds. In the hospital, compresses are purchased from the supplier either as ready-to-use sterile packs or as non-sterile bulk products to be sterilized by the central sterilization department. In this work, we aimed to carry out a comparative pharmaco-economic study as a decision-support tool for healthcare institutions, capable of providing quantified economic data in order to rationalize the choice between purchasing sterile compresses and sterilizing clean compresses in the hospital. Our study showed that the strategy of sterilizing surgical compresses in the hospital is the most economical strategy for healthcare institutions. We found that the acquisition price of one sterile surgical compress is 3.74 MAD, whereas the sterilization cost of a surgical compress with the same characteristics is 0.29 MAD. This therefore represents a saving of 3.45 MAD per unit, i.e. a saving of 92.25% of the amount. Annually, the HMIMV-Rabat sterilization department sterilizes approximately 1,300,000 compresses, corresponding to a saving of 4,485,000.00 MAD/year.

Keywords: Surgical compresses, pharmaco-economic study, cost, medical devices, sterilization.

INTRODUCTION

Over recent years, health policies have undergone many transformations, generally centered on patient protection. Health systems are therefore facing numerous challenges resulting from rising expenditure, growth of the ageing population and resource shortages [1]. Consequently, expenditure control has become the main objective pursued by public authorities in the management of healthcare institutions [2]. Medico-economic evaluations provide a means of informing choices between different strategies by comparing their costs and benefits, thereby enabling better allocation of resources [1].

At present, hospital logistics services in general, and sterilization in particular, seek to minimize the costs related to sterilization activities.

Several methods are used to assess sterilization costs, with different levels of relevance depending on the degree of alignment and consistency between their objectives and the issues faced. Each method provides different management information, and the aim is to determine whether this information is sufficiently adequate to guide hospital structures toward greater efficiency and competitiveness [3].

Assessing the sterilization cost of an item first requires identifying the different activities that define the sterilization process. Initially, the process must be divided into distinct steps to facilitate understanding. This breakdown of the sterilization process is facilitated, on the one hand, by the centralization of activities (central sterilization) and, on the other hand, by its organization according to the forward-flow principle.

For the conduct of our study, we relied on a sterilization-cost assessment method recommended in the Good Sterilization Practice (GSP) guide. In Chapter 15, point 4, "Cost assessment", it proposes a cost-assessment method applicable to the calculation of the production cost of sterile items within the sterilization department.

The production cost of a sterile item corresponds to the algebraic sum of two cost categories: the cost of the raw materials used, whether single-use or reusable, and the sterilization cost, including all charges mobilized for the preparation of a sterile item [3].

The objective of this study is to evaluate the economic value of sterilizing surgical compresses in a hospital setting.

MATERIALS AND METHODS

This was a comparative cross-sectional analytical study based on the cost-minimization method, comparing the cost of purchased sterile compresses with that of in-situ sterilization at HMIMV. The raw materials used were clean 10 x 10 cm compresses, 150 mm x 200 m paper/plastic sterilization-reel rolls and physico-chemical integrators. The equipment included an LX LEQUEUX KH740 autoclave (1200 L, 10,000 compresses/cycle) and a TS46IVSB-LEF heat sealer. The steam sterilization process at 134°C for 18 minutes included packaging (6 compresses/pouch), sealing, autoclaving and storage. The total cost included raw-material, energy, depreciation, maintenance and personnel costs. The study was conducted prospectively in March 2021 through direct observation within the central sterilization department.

Raw-material costs

Cost of clean compresses

After analyzing the sterilization records for compresses, we found that the sterilization of compresses was performed daily from Monday to Friday throughout the year at a constant rate of 5,000 compresses per day, i.e. 25,000 compresses per week.

The price of clean compresses was provided by the Medical Devices Unit of the Pharmacy Department of Mohammed V Military Teaching Hospital.

Costs of the paper/plastic sterilization reel

The sterilization reel is supplied by the Reagents Unit of the HMIMV Pharmacy Department.

Using the same procedure as for clean compresses, requests for reel rolls are expressed according to needs by the senior nurse of the department through the IT system (Esculap). A department agent then collects the allocation from the pharmacy after validation of the request by the pharmacist responsible for the Reagents Unit.

It is important to note that one reel roll measures 200 meters (20,000 cm) in length, whereas each pouch is cut to a length of 20 cm. Therefore, one reel roll produces 1,000 packaging pouches.

Cost of physico-chemical integrators

Physico-chemical integrators are indicators used to monitor the physico-chemical conditions of the sterilization cycle. They are essential for each sterilization cycle, allowing the use of a single unit.

These reagents are supplied by the Reagents Unit of the military hospital pharmacy, according to the same procedure as the reel rolls mentioned above.

Cost of personnel involved

To estimate the production cost of the personnel involved in the sterilization operation, it was first necessary to calculate the number of technicians involved, determine the time spent by each of them and then deduct this time from their salaries.

Because the sterilization department performs many other tasks, we could not precisely calculate the number of people involved in this work and the time they devote to it. We therefore timed the time spent by one technician on this work, in order to deduct it from the hourly wage and derive the cost.

All steps of this sterilization operation were carried out alternately by four technicians.

Calculation of the time required to prepare packaging pouches:

This step is carried out under the responsibility of two staff members: one in charge of manually cutting the reel roll to the appropriate length (20 cm for each pouch), and the other in charge of sealing it.

- ✓ Calculation of the time required to cut the reel

We took ten measurements for each step in order to reduce the risk of error.

Table I: Number of pouches cut by one technician in one minute

No. of measurements	1	2	3	4	5	6	7	8	9	10	Mean
No. of pouches cut per minute	26	28	27	23	25	28	27	26	25	30	26.5

Each day, the sterilization department produces 833 pouches (each pouch contains 6 compresses). Therefore, the time required for one technician to produce 833 pouches is equal to No.P.P.D/No.P.P.M = 833/26.5 = 31.43 minutes.

No. P.P.D: number of pouches produced per day

No. P.P.M: number of pouches produced per minute

It is important to note that a technician cannot work for 31.43 minutes without rest; therefore, we estimated a rest period of four minutes for one technician to produce 833 pouches.

A technician therefore spends 35.43 minutes cutting one reel roll into pouches with a length of 20 cm.

We denote T1 = 35.43 minutes

Calculation of the time required for the first sealing of pouches

The cut pouches are then sealed by another technician. This operation follows the previous one and is performed using a heat sealer.

Table II: Number of pouches sealed by one technician per minute

No. of measurements	1	2	3	4	5	6	7	8	9	10	Mean
No. of pouches sealed per minute	23	29	26	26	25	27	28	25	26	27	26.2

The time required to seal 833 pouches (first sealing of empty pouches) is equal to No.S.P.D/No.S.P.M = 833/26.2 = 31.79 minutes.

No.S.P.D: number of pouches sealed per day
No.S.P.M: number of pouches sealed per minute

On the same basis as above, 4 minutes of rest were added, since the operator cannot work continuously for 31.79 minutes without a break. This operation may therefore be performed in a total time of 34.79 minutes.

We denote T2 = 34.79 minutes

❖ **Calculation of the time required for packaging itself**

This step consists of packaging 6 compresses in one pouch.

✓ **Time required for separation of compresses**

This step is carried out jointly by two technicians, who work in parallel during other steps of the cycle.

To determine precisely the time required to perform this step, we used the following method:

The separated compresses were arranged in groups of 6, after which we counted the number of units that one technician could prepare in one minute.

Table III: Number of compress units produced by one technician per minute

No. of measurements	1	2	3	4	5	6	7	8	9	10	Mean
No. of units produced per minute	9	10	13	10	9	12	10	11	9	12	10.5

A technician can produce an average of 10.5 units per minute, whereas two technicians produce 21 units per minute. We recall that 833 units were produced per day, by a simple mathematical calculation:
The time required to carry out this operation is equal to No. U.P.D/No. U.P.M.

No. U.P.D: number of units produced per day
No. U.P.M: number of units produced by one technician in one minute

The time devoted by two staff members to this step is therefore: No. U.P.D/No. U.P.M = 833/21 = 39.66 minutes for each of them.

We denote:

- For the 1st technician: T3 = 39.66 minutes
- For the 2nd technician: T4 = 39.66 minutes

Time required to fill one pouch with 6 clean compresses

This step is also performed by two technicians who carried out the first two steps (T1 and T2), alternately, because the first two steps are prepared in advance (almost 30 minutes before the other steps).

Table IV: Number of pouches filled by one technician in one minute

No. of measurements	1	2	3	4	5	6	7	8	9	10	Mean
No. of pouches filled per minute	11	14	15	14	12	17	14	12	13	12	13.4

According to the previous table, each technician can fill 13.5 pouches per minute, and since 833 pouches were produced per day, the two technicians each spend 30.85 minutes performing this step.

Finally, the time required to complete this procedure is:

- For the 1st technician: T'1 = 30.85 minutes
- For the 2nd technician: T'2 = 30.85 minutes

We wrote T'1 and T'2 because these two persons had already performed other functions belonging to this operation.

Time required for sealing filled pouches

The filled pouches undergo a final step before being placed in the sterilizer. They are sealed with a semi-automatic heat sealer, a step performed by a single technician, whose time is deducted for this operation and calculated using the following table.

Table V: Number of pouches sealed by one technician in one minute

No. of measurements	1	2	3	4	5	6	7	8	9	10	Mean
No. of pouches heat-sealed per minute	19	21	30	25	18	26	25	20	24	29	23.7

We recall that the sterilization department produces 833 pouches of sterile compresses each day and that the time required to seal them is 35.14 minutes.

- We denote T'3 = 35.14 minutes

Table V: Summary of staff time involved in each sterilization step.

Steps performed	Staff involved	Time spent in minutes	Time spent in hours
Cutting of the sterilization reel	-P1	T1=35.43	0.59
Sealing of empty pouches	-P2	T2=34.79	0.57
Separation of compresses into units of 6 compresses	-P3 -P4	T3=39.66 T4=39.66	0.66 0.66
Filling of pouches	-P1 -P2	T'1=30.85 T'2=30.85	0.51 0.51
Sealing of filled pouches	-P3	T'3=35.14	0.58
Total		246.38	4.08

We concluded that carrying out one sterilization cycle of 5,000 surgical compresses requires the continuous work of 4 technicians for 1.02 hours.

However, to calculate the cost of the 4 people involved in this sterilization operation, we deducted from their monthly salaries an amount corresponding to the number of working hours dedicated to this operation.

Cost of equipment used

Water and energy consumption by autoclaves

Steam sterilizers are considered major consumers of water and energy in sterilization departments. This energy is supplied either as steam produced by the boiler room through a heat exchanger, or by electricity: 539 kcal/kg of water is required to convert it into steam [4].

The energy used in the sterilization department for operating sterilizers comes from different sources, depending on the device used, which may operate on electrical energy, diesel fuel or a boiler system supplying it with steam.

Autoclaves are connected to a reverse-osmosis water supply system, which is an important component of the sterilization cycle. Two categories of water are used by sterilizers:

- ✓ Water supplying the generator: generally reverse-osmosis water that is converted into steam
- ✓ Water supplying the vacuum-generation system

In our study, we focused on a sterilizer (LX LEQUEUX KH740) that uses electrical energy. The cost estimation for the energy consumption of this autoclave was performed in collaboration with the Biomedical Department and the hospital Electricity Department.

Water consumption by the autoclave was determined by calculating the quantity of water used per sterilization cycle and converting it into cost by multiplying the number of liters consumed by the corresponding price per liter of water.

Calculation of autoclave depreciation cost

The HMIMV central sterilization department has three autoclaves (LX LEQUEUX KH740) for steam sterilization: one operating on electrical energy and the other two on diesel fuel. These autoclaves were installed in 1997 and are periodically maintained and serviced to ensure proper department operation.

Autoclave depreciation was calculated according to the duration of use, estimated at 23 years. To derive this cost, we extracted the operating time for each sterilization cycle from the total duration of use, and then converted this time into costs.

Calculation of sealing-equipment cost

The sealing of packaging pouches for compresses is performed by a single heat sealer dedicated to this activity. The device used is a continuous-band heat sealer, version TS46IVSB-LEF.

According to the manufacturer, the depreciation period of the TS46IVSB-LEF heat sealer is set at 5 years. Knowing that the machine operates for one hour per cycle, we can determine the corresponding depreciation cost, which is equal to the acquisition cost divided by the number of operating hours.

Annual maintenance cost of sterilizers

Sterilizer maintenance is a task performed by the Biomedical Department. It involves a non-negligible budget and must therefore be included in sterilization costs. This cost was estimated through collaboration between the Biomedical Department and the Equipment Department.

RESULTS AND DISCUSSION

Analysis of raw-material cost results

Cost of clean compresses

The acquisition cost of clean compresses is 19.53 MAD for a box of 100 compresses; therefore, the acquisition cost of a single compress is 0.1953 MAD.

Table VI: Cost incurred for purchasing clean compresses

Item	P.A.B.C En (MAD)	No.C.B	P.A.S.C En (MAD)	C.D.J.C En (MAD)
Clean compresses 10 cm x 10 cm	19.53	100	0.1953	976.5

P.A.B.C: Purchase price of one box of clean compresses
No.C.B: Number of compresses per box
P.A.S.C: Purchase price of a single compress
C.D.D.C: Cost of the daily compress allocation

Sterilization-reel costs

The sterilization reel roll (paper/plastic, 200 m x 150 mm) costs 373 MAD. Each roll produces 1,000 pouches for the packaging of 6 compresses; therefore, the cost corresponding to the packaging of a single compress is 0.062 MAD.

Table VII: Costs incurred for purchasing packaging material (sterilization reel)

Item	P.A. R En (MAD)	Nb.S.R En (MAD)	P. S(P.A.R/Nb.S.P) En (MAD)	P.C En (MAD)
Paper/plastic reel roll 150 mm x 200 m	373	1000	0.373	0.062

P.A.R: Purchase price of one reel roll
No.P.R: Number of pouches produced by one reel roll
P.P: Price corresponding to one reel pouch
P.C: Price corresponding to the packaging of one compress

Cost of physico-chemical integrators

Physico-chemical integrators are purchased from the supplier in packs of 100 units at a price of 156 MAD. Knowing that one sterilization cycle of 5,000 compresses requires a single unit, the cost corresponding to sterilization of one compress is therefore 0.000312 MAD.

Table VIII: Cost of purchasing physico-chemical integrators

Item	P.P.B in (MAD)	No.U.B	U.C in (MAD)	C.C en (MAD)
Physico-chemical integrators	156	100	1.56	0.000312

C.A.B: Purchase price of one box
No. U.B: Number of units per box
C.U: Cost of each unit
C.C: Cost corresponding to the sterilization of one compress

Analysis of personnel-cost results

The production cost of personnel involved in compress sterilization was deducted from their monthly salary by calculating the number of staff members involved in performing this operation and the time devoted to it.

This sterilization operation is carried out by 4 technicians,

Table IX: Summary of the total cost of personnel involved

Persons involved	S.M En (MAD/M)	S.H En (MAD/H)	Working time in hours	Cost corresponding to the number of hours in (MAD)
P1(T1+T'1)	5000	20.83	1.1	22.91
P2(T2+T'2)	5000	20.83	1.08	22.49
P3(T3+T'3)	5000	20.83	1.24	25.82
P4(T4)	5000	6.944	0.66	13.74
Total				84.63

M.S: Monthly salary of a technician
H.W: wage corresponding to one hour of work

The previous table presents the total production cost of personnel involved in the sterilization of surgical compresses. To calculate this cost, we extracted from the monthly salary of the four technicians involved the amount corresponding to the number of working hours devoted to performing this task.

The result of this calculation is expressed in MAD. We found that the cost corresponding to one sterilization cycle of 5,000 compresses is 84.63 MAD, i.e. 0.016 MAD per compress.

Percentage of time devoted to compress sterilization by four technicians

The following table presents the number of staff members involved in compress sterilization, limited to 4 (P1, P2, P3 and P4).

Table X: Number of persons involved in this operation and their percentage of daily activity devoted to compress sterilization

No. P	D.W.H in hours	No. H.S.C	%
P1	8	1,1	14%
P2	8	1,08	14%
P3	8	1,24	16%
P4	8	0,66	8%

No.P: Number of personnel
D.W.H: Daily working hours
No.H.S.C: Number of hours devoted to compress sterilization
%: Percentage of a technician's daily activity devoted to compress sterilization

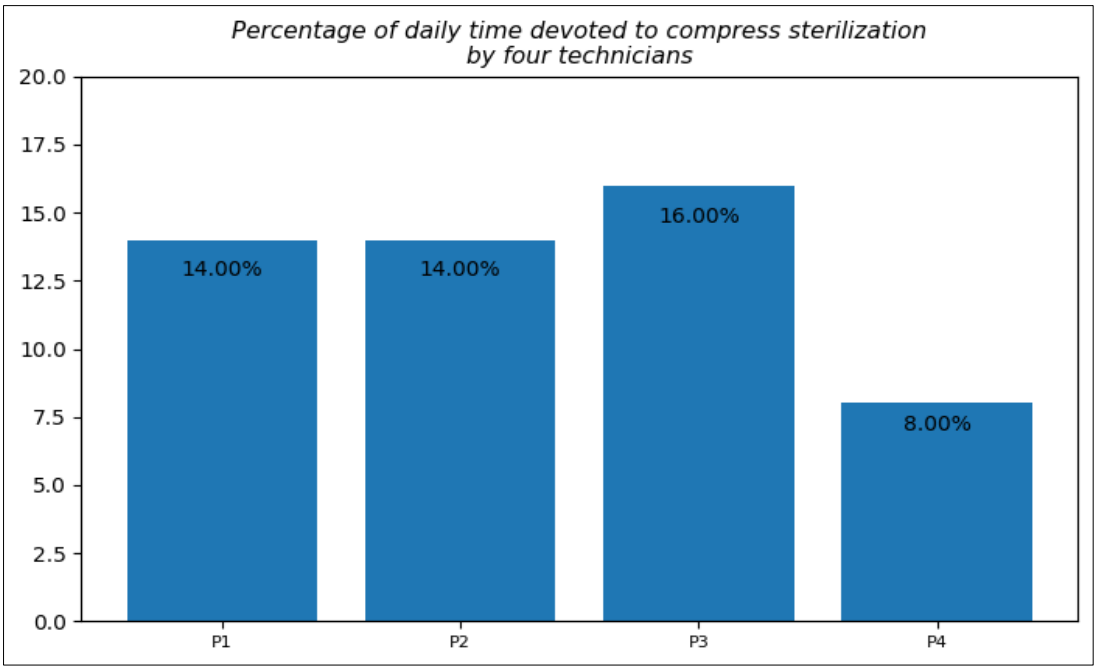

Figure 1: Graphical representation of the percentage of daily time devoted to compress sterilization by 4 technicians

Based on the results obtained, we found that compress sterilization is performed by four persons (P1, P2, P3 and P4), with 14% of daily time devoted by P1 and P2, 16% by P3 and 8% by P4.

Place of the compress-sterilization operation among the different activities

Compress sterilization is an operation performed in parallel with other sterilization operations for medical devices, namely receipt of contaminated equipment, washing, disinfection, packaging, sterilization itself, storage and, finally, distribution of sterile medical devices to operating rooms and the different hospital departments. We therefore chose to determine the place of this operation within all department activities.

To determine the place of this activity, it is first necessary to determine all department personnel and the daily working schedule of each person.

The department has a team of 20 technicians, with a working schedule of 8 hours per day (160 working hours per day), distributed across all department units, each involved in their own tasks.

We had already calculated the number and time involved in the compress-sterilization operation (Tables VII and XI).

Table XI: Percentage of activity dedicated to compress sterilization

Number of persons	Working hours/person	Total number of working hours	No.H.S.C	P.T.S.C	P.T.O.A
20	8	160	4,08	2.55	97.45

No.H.W.P: Number of working hours/person/days
No.T.W.H: Total number of working hours/days
No.H.S.C: Number of hours committed to compress sterilization = No.H.W.P x No.T.W.H
P.T.S.C: Percentage of time devoted to compress sterilization = No.H.S.C/No.T.W.H x 100
P.T.O.A: Percentage of time devoted to other department activities = (No.T.W.H - No.H.S.C)/No.T.W.H x 100

We found that the operation of sterilizing 5,000 compresses per day accounts for 2.55% of the time required to perform all department activities.

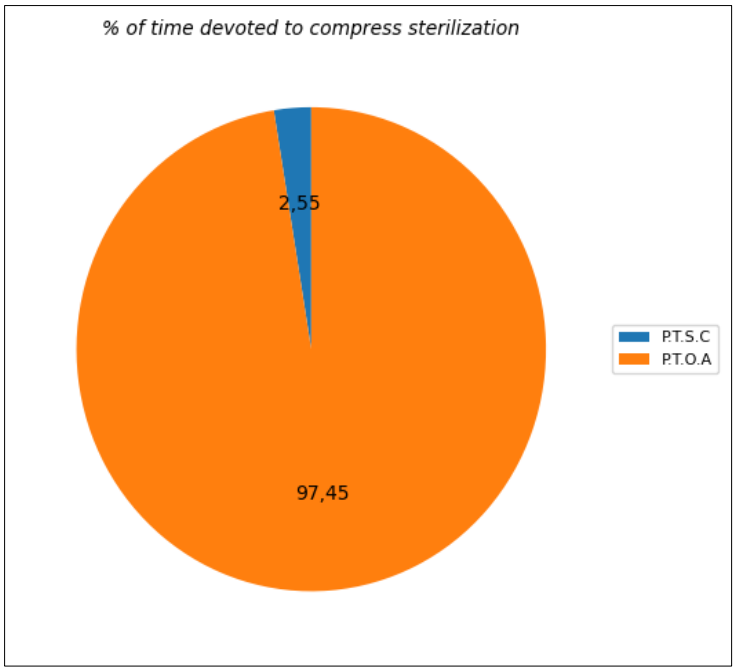

Figure 2: Schematic representation of the time devoted to compress sterilization.
P.T.S.C: % of time devoted to compress sterilization.
P.T.O.A: % of time devoted to other department activities

Analysis of equipment-cost results

Energy consumption by autoclaves

The autoclave dedicated to compress sterilization operates with two electrical generators powered by electricity, with a power rating of 72 kWh for each generator. The cost corresponding to consumption of one kWh of electrical energy is 0.90 MAD, whereas the generator operating time during one sterilization cycle is 0.66 h; therefore, the total cost of electrical energy consumption for one cycle is 85.53 MAD. To determine the energy-consumption cost incurred for sterilizing a single compress, we divided the total cost of one cycle by the number of compresses sterilized per cycle.

Table XII: Energy consumption by the sterilizer during one cycle.

Item	P in kWh	T. F en Heur	C.kW in (MAD)	C.A.C in (MAD)	C.S.C En (MAD)
LX LEQUEUX KH740 sterilizer	144	0.66	0.90	85.53	0.0171

P: Power in kilowatt-hours
O.T: Operating time in hours
C.kW: Cost of one kW of electricity
C.A.C: Cost of one autoclave cycle
C.S.C: Energy cost used for sterilizing a single compress.

Water consumption by autoclaves

Table XIII: Water consumption by one autoclave for one operating cycle

Item	No.L.C.C	P.M.C.E En MAD	P.L.W	C.S.Cy in (MAD)	C.S.C En (MAD)
LX LEQUEUX sterilizer	560	6.45	0.0064	3.612	0.00072

No.L.C.C: Number of liters of water consumed per cycle
P.M.C.W: Price of one cubic meter of water
P.L.W: Price of one liter of water
C.S.Cy: Cost of one sterilization cycle
C.S.C: Cost corresponding to sterilization of one compress

According to the sterilizer technical data sheet, one sterilization cycle consumes approximately 560 L of water, which is the quantity required to perform all steps (vacuum creation and steam production).

After our calculation, we concluded that the cost of one sterilization cycle is 3.612 MAD. Knowing that one sterilization cycle produces 5,000 compresses, the cost corresponding to sterilization of one compress is 0.00072 MAD.

Autoclave depreciation

To simplify the calculation, we converted the duration of use from years into hours (=24 x 30 x 12 x 23 = 198,720 hours), and divided the acquisition cost of the sterilizer (800,000 MAD, provided by the Equipment Department) by the total number of hours since its installation in 1997. We then extracted the time required for one sterilization cycle (equal to 1 hour), which allowed us to determine the cost related to sterilizer depreciation per hour of operation.

We concluded that the depreciation cost per hour is 4.02 MAD. Since compress sterilization is performed at a rate of one 1-hour cycle per day, the depreciation cost corresponding to sterilization of one compress is equal to 4.02 divided by the number of compresses sterilized per day (5,000 compresses).

Table XIV: Calculation of sterilizer depreciation

Item	C.A.S in (MAD)	D.U in hours	O.T.S.C in hours	C.A.S.H in (MAD)	C.S.C. in
LX LEQUEUX KH740 sterilizer	800.000.00	198.720	1	4.02	0.000804

C.A.S: Purchase cost of the sterilizer
D.U: Duration of use
O.T.S.C: Operating time of a sterilizer during one sterilization cycle
C.A.S.H: Cost corresponding to sterilizer depreciation per operating hour
C.S.C: Depreciation cost corresponding to sterilization of a single compress

Cost of sealing equipment

The acquisition cost of a TS46IVSB-LEF heat sealer is 39,583.34 MAD, depreciated over 5 years (43,200 hours).

Table XV: Cost of pouch sealing

Designation	C.A in MAD	S.L in hours	Depreciation per hour	C.C.S.C in MAD
Heat sealer (TS46IVSB-LEF)	39583.34	43200	0.91	0.00018

C.A: Acquisition cost
L.S: Service life in hours
C.C.S.C: Cost corresponding to sterilization of a single compress

Annual maintenance cost of sterilizers

The annual maintenance cost of one sterilizer is estimated by the Biomedical Department at 7,000.00 MAD/year. We converted this estimate into cost per hour in order to determine the cost corresponding to one cycle (1 hour of sterilizer operation) and derive the cost of one compress, while each sterilization cycle produces 5,000 compresses.

The following table presents the maintenance costs of the different sterilizers, knowing that one sterilizer can perform several cycles per day and that compress sterilization represents only 2.5% of the department's total activity (Figure 21).

Table XVI: Annual maintenance cost of one sterilizer

Maintenance and servicing	Cost/ an en (MAD/an)	Cost/h en (MAD/h)	Costs/Compresse en (MAD)
Sterilizer	7000	0.81	0.00016

Analysis of the total cost of this operation

Our study determined the cost of sterilizing one woven surgical compress (10 cm x 10 cm) within the sterilization department in order to compare it with the same types of compresses (10 cm x 10 cm) purchased sterile from suppliers. This cost was estimated at 0.293 MAD per compress.

Table XVII: Summary of the different costs related to sterilization of one compress

Different costs incurred	Amount corresponding to sterilization of one compress in MAD
Cost of clean compresses	0.1952
Cost of physico-chemical integrators	0.0003
Cost of packaging reel	0.062
Personnel cost	0.016
Energy-consumption cost	0.017
Water-consumption cost	0.00072
Sterilizer depreciation cost	0.00080
Sterilizer maintenance cost	0.00016
Heat-sealer cost	0.00018
Total sterilization cost of one compress	0.293

The table below summarizes the overall cost of using sterilization for one surgical compress in a hospital setting.

The objective of this study is to demonstrate the economic value of in-situ sterilization of compresses compared with compresses purchased already sterile, knowing that the effectiveness of both types of compresses is the same.

Expression of the different costs as percentages

Analysis of our results showed that the cost of sterilizing surgical compresses in a hospital setting represents all the resources mobilized to produce sterile compresses, such as direct costs and indirect costs.

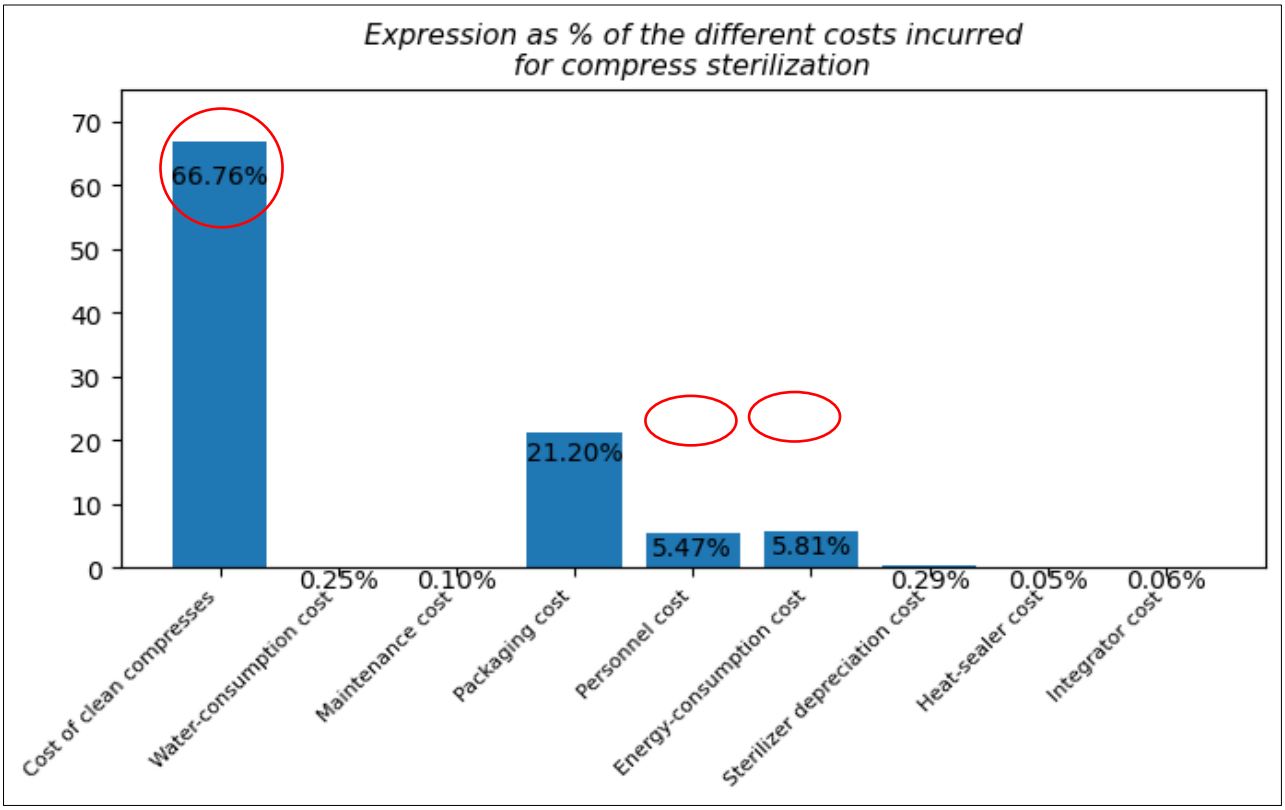

Figure 3: Graphical representation of all costs involved in compress sterilization

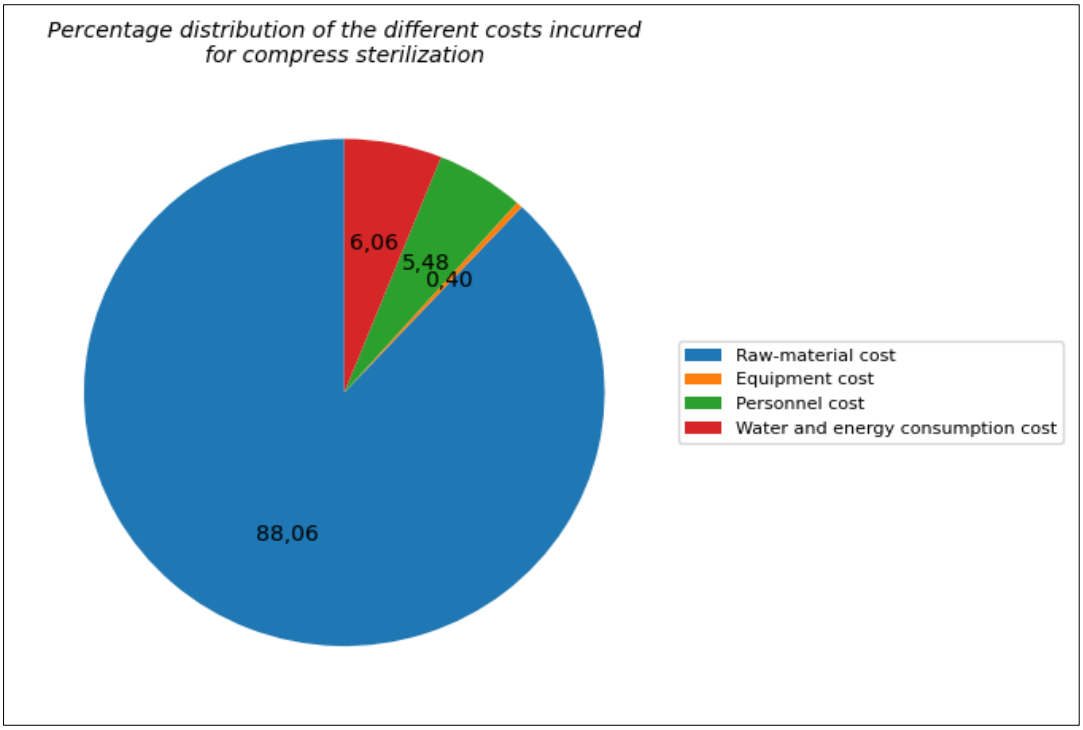

Figure 4: Distribution of the different costs involved in the compress-sterilization operation

DISCUSSION OF RESULTS

Direct and indirect sterilization costs

Sterilization costs represent all resources mobilized around this operation. Direct costs and indirect costs are distinguished.

Direct costs

These are costs directly attributable to the purchase of raw materials. They correspond to the value of all resources consumed directly for the production of sterile compresses: purchase of clean compresses, purchase of the sterilization reel and purchase of physico-chemical integrators.

Indirect costs

These are the costs of indirectly induced negative consequences. They correspond to the costs associated with sterilization, namely personnel production cost, energy-consumption cost and equipment depreciation cost.

Table XVIII: Representation of direct and indirect costs

	Types of costs	Costs in MAD	Total	Percentage
Direct costs	Purchase cost of clean compresses	0.1952	0.257	88.07%
	Purchase cost of the sterilization reel	0.062		
	Purchase cost of physico-chemical integrators	0.0003		
Indirect costs	Personnel cost	0.016	0.0348	11.93%
	Energy-consumption cost	0.017		
	Water-consumption cost	0.00072		
	Sterilizer depreciation cost	0.00080		
	Sterilizer maintenance cost	0.00016		
	Heat-sealer cost	0.00018		

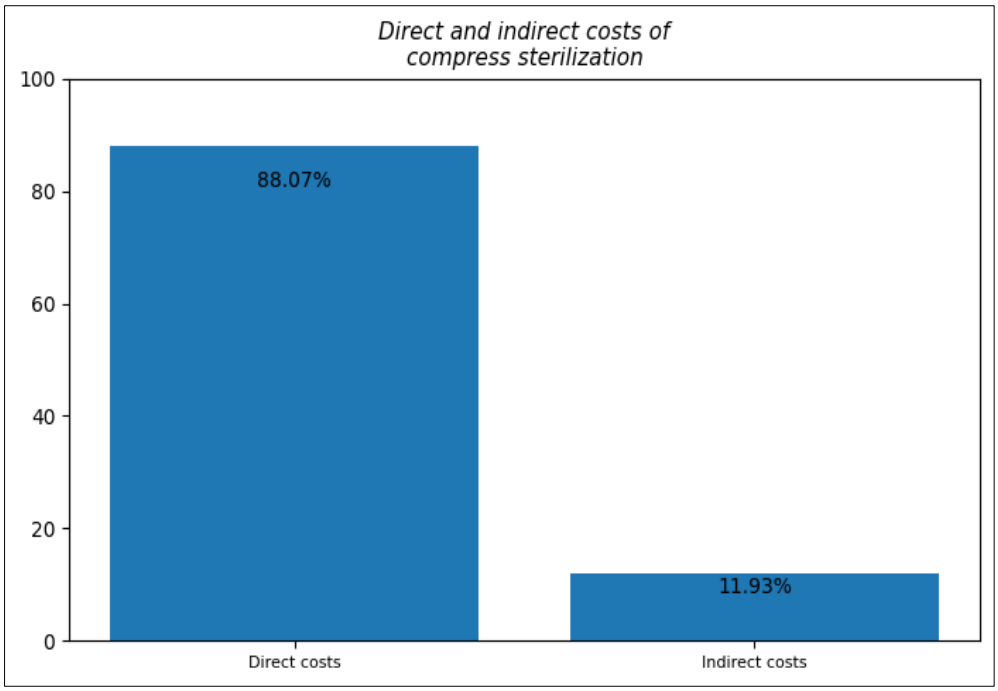

Figure 5: Graphical representation of the two types of costs mobilized for compress sterilization

Analysis of our study results showed that direct costs of compress sterilization in a hospital setting represent 88.07%, while indirect costs represent 11.93%.

The percentage distribution of the different sterilization costs shows that 66.76% of the total sterilization cost is dedicated to the purchase of clean compresses, 21.20% to the purchase of packaging materials, 5.81% to energy consumption and 5.47% to the cost of personnel involved.

Analysis of our results shows that sterilization of compresses in a hospital setting requires mobilization of four cost categories: 88.28% of the costs incurred correspond to raw materials, 0.40% to equipment used, 5.49% to personnel involved in this operation and 6.08% to water and energy consumption costs.

Analysis of water- and energy-consumption results

Exploitation of our study results showed that 6.08% of the cost mobilized for compress sterilization relates to water and energy consumption, with 5.81% corresponding to electrical energy consumption and 0.25% to water consumption.

Price of compresses purchased sterile from suppliers

According to the Medical Devices Unit of the pharmacy, the price of a pouch containing two sterile compresses is 7.49 MAD; that is, one sterile compress (10 cm x 10 cm) costs 3.745 MAD when purchased already sterile from the supplier, whereas the sterilization cost of one compress with the same characteristics is 0.29 MAD.

Table XIX: Purchase price of sterile woven compresses

Designation	Price of a pouch of 2 compresses in MAD	Price of one compress in MAD
Sterile compresses (10 cm x 10 cm)	7.49	3.745

Comparison between the sterilization cost of one compress and its sterile purchase cost

The price of sterile woven compresses (10 cm x 10 cm) was provided by the Medical Devices Unit of the HMIMV pharmacy. Sterile compresses are purchased in packs of 10 pouches, each containing two sterile compresses (10 cm x 10 cm).

Based on analysis of our results, we found that the acquisition cost of a sterile woven surgical compress from the supplier is much higher (3.745 MAD) than the sterilization cost (0.29 MAD) of a compress with the same characteristics (size, composition and effectiveness).

Table XX: Comparison of the acquisition cost and sterilization cost of one compress

Designation	Purchase price of one sterile compress in MAD	Sterilization price of one compress in MAD
Sterile compresses (10 cm x 10 cm)	3.745	0.29

The following figure presents a graph showing the cost difference between two different strategies for acquiring sterile compresses. It showed that hospital sterilization of one gauze compress saves 3.455 MAD per unit.

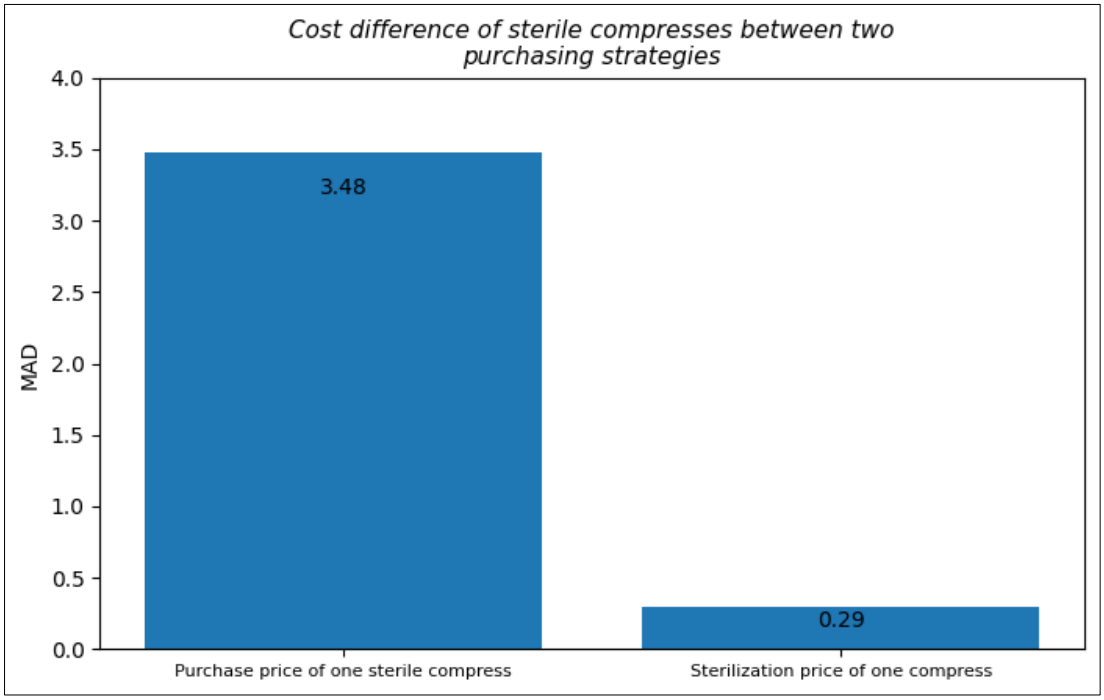

Figure 6: Cost difference between two different strategies for acquiring sterile compresses

Expression of results at annual activity level

Our study was conducted over a 4-week period. During this period, we observed the sterilization of 25,000 compresses per week. The entire quantity produced was intended for the different hospital departments (operating rooms, laboratories, clinical departments, etc.). This enabled us to obtain an idea of the hospital's general consumption of sterile compresses and therefore to determine the annual cost incurred for acquisition of this pharmaceutical product, while comparing the costs of the two supply strategies (purchase of sterile compresses and hospital sterilization of compresses).

The results of our study showed that the hospital consumes 25,000 compresses per week. Knowing that compress sterilization is carried out throughout the year at a constant frequency, annual consumption can therefore be calculated as the number of compresses produced per week multiplied by the number of weeks per year (25,000 x 52 = 1,300,000 compresses).

Table XXI: Comparison of annual costs mobilized for sterile-compress supply.

Designation	Unit price in MAD	Annual consumption	Annual cost in MAD
Compresses sterilized at the hospital	0.29	1300000	377.000.00
Compresses purchased sterile	3.745	1300000	4.868.500.00

One million three hundred thousand is therefore the hospital's annual consumption of sterile compresses. Assuming that the hospital purchases this entire quantity of sterile compresses, it would mobilize an amount of 4,868,500.00 MAD, whereas sterilization of the same quantity of compresses with the same effectiveness costs only 377,000.00 MAD, representing a saving of 92.25% of the annual budget.

In conclusion, sterilization of surgical compresses within HMIMV Rabat allows the hospital to save an annual budget of 4,491,500.00 MAD.

For information, several hospital departments prepare their needs for sterile compresses of different dimensions. Their packaging is performed in the different hospital departments, and they are then sent to the sterilization department to be sterilized.

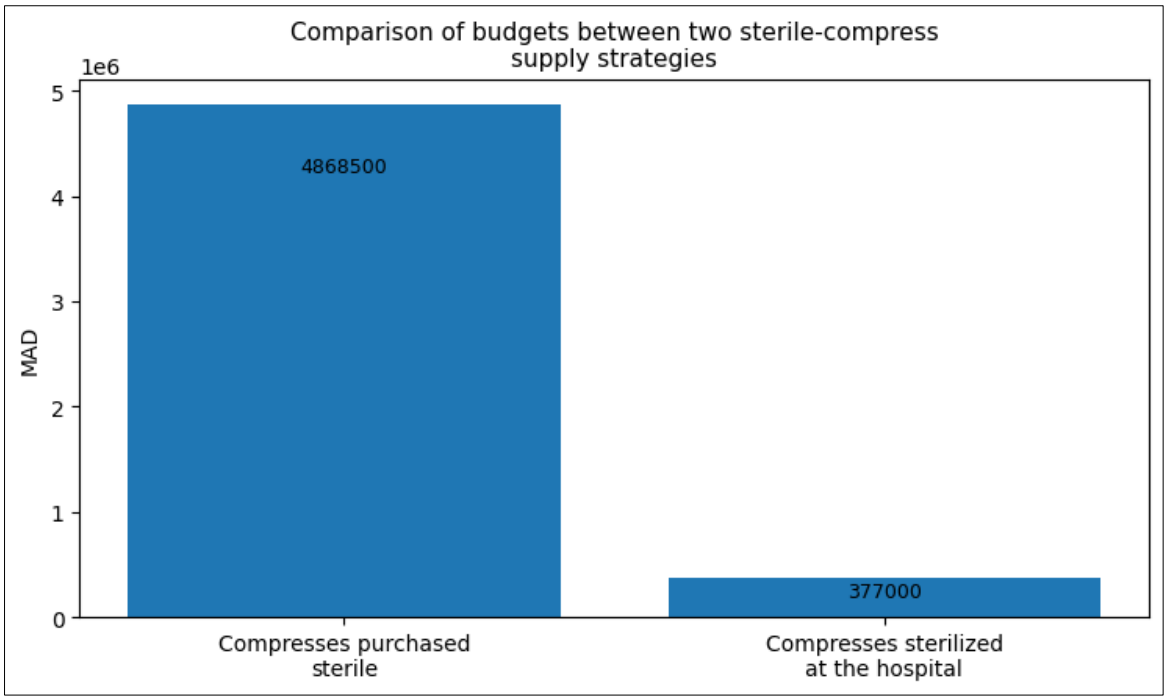

Figure 7: Graphical representation of the annual budget dedicated to compress supply using two different strategies

Discussion of the effectiveness of processed compresses:

Sterilization of compresses was performed using the steam sterilization method, a method described in the GSP [5].

Compresses prepared in the hospital setting differ from those purchased sterile by the content of their packaging: they are packaged in pouches of 6 compresses, whereas the others are packaged in pouches of two compresses. This may facilitate use and reduce compress waste for the user.

Strengths and limitations of our work

Our study aims to demonstrate the economic value of hospital sterilization of woven surgical compresses (10 cm x 10 cm) by the steam sterilization process. This work was performed for the first time in Morocco. It provides a general overview of the practice of in-situ compress sterilization in the hospital.

The method used to calculate the sterilization cost is a validated method recommended by the Good Sterilization Practice (GSP) guide.

Indeed, our literature review focused only on published data. The studies we selected were limited and insufficient for the discussion of our results.

The method we used nevertheless has some limitations. It would be necessary to perform these calculations regularly in order to reassess the proportions and compare the results.

CONCLUSION

The use of sterile surgical compresses in the hospital setting occupies an important place and mobilizes a substantial annual budget. Purchasing this product in sterile form requires additional costs, which we attempted to reduce by sterilizing compresses in the hospital. We conducted a comparative pharmaco-economic study between the purchase cost of sterile compresses and the cost of sterilizing compresses in the hospital.

Our study allows us to conclude that the strategy of sterilizing surgical compresses in the hospital by the steam sterilization process provides an important economic contribution to the hospital, while ensuring safety for staff and users.

Through this study, we attempted to describe the different sterilization steps as well as the costs mobilized for each step, in order to clarify this strategy's procedures for other healthcare institutions and to integrate this compress-sterilization strategy into all hospitals in the Kingdom.

Training personnel in the field of hospital sterilization constitutes an important approach to the prevention of nosocomial infections and health economics. Therefore, we recommend continuing training in pharmaco-economics and pharmaco-epidemiology at the Faculty of Medicine and Pharmacy of Rabat, as well as an internship in the sterilization department for pharmacy students.

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