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An interdepartmental, standardized equipment pool

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Aim To solve problems concerning patient equipment with emphasis on patient care, nursing quality and better nursing management.
Methods A monitoring system, designed to follow the patient around in the hospital was discovered. Based on this concept a special, standardized pool system managed by the Clinical Engineering Department was developed.
Results An all-department standardization of monitors and pumps was tried. With pumps it was a success. With monitors, two of 21 departments preferred non-standardized equipment. The equipment pool has successfully been run for 5 years.
Conclusions An evaluation showed that nursing care is better and that only 2% of those asked disapproved of the system. The pool eliminated problems like lack of equipment when needed, the wrong type of equipment found, lack of fitting disposables, the items that could be found being out of order or too dirty to be used. Nurses no longer waste time searching for equipment ready for use. Bedside equipment in working order can always be found in one of the storerooms. As a result, patient safety was greatly enhanced. We also show that this is economically a good system.

Keywords: nursing quality, equipment pool, hospital management, standardised equipment

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Introduction

This paper will describe the setting up and running of an equipment pool at Rikshospitalet and also present a general model for how to set up such a system for other equipment in different environments.

In general, doctors are becoming increasingly dependent on sophisticated medical devises to deliver a high standard of patient care. The fact that equipment management is often not a top priority with hospital administrators led to the result that an Engineering Department assumed a new role and it is shown in this paper how a successful equipment pool can be run.

In 1989, it was decided to move 'Rikshospitalet' and funds were provided for buying equipment when moving into new buildings. The planning of equipment procurement started in 1996. Putting up new buildings and purchasing great amounts of new equipment provided a unique chance to consider the whole aspect of a patient's technical environment in the hospital.

Some facts about Rikshospitalet – employees: 4600; area: 136 000 m^2; number of rooms: 7000; number of beds: 585; operating theatres: 27; Rikshospitalet owns a total of 14 600 pieces of medical equipment worth 990 million Norwegian krone (NOK).

Amount of equipment in the pool – syringe pumps: 430; infusion pumps: 268; monitors: 344.

Identifying the problems

In the old hospital problems were experienced connected to basic patient equipment-like pumps and monitors.

The hospital had a number of different brands and types of equipment. Thus, a patient moving from one department to another had to be disconnected from one brand of pump, the infusion line changed and the patient established on another pump. The same procedure had to be done to all cables for the monitoring system.

Also, a number of items were used only infrequently. This often meant that care and maintenance were neglected. The hospital owned too many different models of equipment that made storage of disposables very room-consuming and expensive. User training and training of technical staff were harder to perform when there were so many different types of equipment. This unique opportunity of purchasing so much equipment in one go could be used to improve the utilization of medical equipment in patient care and also to reduce the time and effort spent in locating equipment.

Problems that needed a solution:

- Too many different makes of equipment of the same kind (for instance eight different makes of pumps).
- Too many types of disposables.
- The wrong number of items located in the different wards.
- Infrequent use of some of the equipment caused bad maintenance and negligence of hygiene.
- Too much time and frustration spent on finding equipment ready for use.

Anticipated problems that needed addressing:

- Departments not wanting to standardize.
- A lack of agreement about what kind of equipment to buy.
- A general negligence due to common ownership.
- Departments not trusting the system, therefore storing equipment locally.

Literature review

In the literature, not very much can be found about standardized, pooled equipment handling.

Klepper and Geiger (1996) described a fully automated equipment management and storage system with focus was on maintenance. Hertz (1996) reported one based on the 1996 draft of the AAMI equipment management standard (AAMI EQ56). Franklin and Altman (1996) suggested one based on assessment and management, with cost reduction as the goal. They were describing more interesting topics like clinical necessity, compatibility with existing systems and standardization. Finally, Gentles (2000) describes a central equipment pool. In this system, the Clinical Engineering Department (CED) bought a number of pumps and rented them out to the medical departments as needed.

None of these articles describe what was seen as our goal, namely to standardize the problem areas which emphasize on patient safety and nursing management (Appendix).

The British National Patient Safety Agency (2004) issued a 'Safer practice notice' called 'standardizing and centralizing infusion devices – a project to develop safety solutions for NHS trusts. Evaluation – executive summary'. This notice concludes that standardizing infusion devices reduce the identified problems of lack of competence-based staff training and unsystematic purchasing and management of infusion devices. This notice recommends what has been done at Rikshospitalet. However, it does not go into details on the practical issues.

Unfortunately nothing could be found in the literature to help us identify the pitfalls in the process of starting a pool system.

The purpose of this paper is to present ideas and results after 5 years of running an equipment pool.

The primary goals were better patient care and higher nursing quality, not economics. However, economical data will also be presented.

Method

In the process of choosing suppliers of monitoring equipment, a technical solution that allowed monitors to follow the patient and collect data 'on the run' for later storage in data systems was discovered. From this knowledge came the idea that maybe several types of equipment could be identical and follow the patient all the way through the hospital, instead of each department having its own type and brand.

It was decided to standardize patient monitors, syringe pumps and infusion pumps. This meant we could organize a system so that this equipment could travel around in the hospital with the patients and be part of a central pool when not in use.

Reaching a decision about what kind of equipment to buy was difficult. Many opinions were expressed and a lot of discussions went on. A number of people were against the idea of having identical equipment all over the hospital.

One person was hired on a full-time basis to run the system. It was decided from the start that this person had to be as neutral as possible, not a technical engineer and preferably not a nurse. We ended up hiring a biotechnologist with a wide knowledge of hospitals in general.

In the beginning the pool system was organized as a project until an evaluation could be done.

Some time before the move to our new location, but after most of the equipment was bought, we set down the rules for the pool system. This ruling document contained a definition of which equipment types and which types of accessories were to be included in the pool, rules for daily use; who was responsible for hygiene, level of stock at the different departments and the return of equipment to a central storeroom. Furthermore, it had a chapter on maintenance of the equipment and what to do when needing more equipment temporarily or permanently. Rules for highlighting problems and how to solve them were an important factor in the system. Rules for running the pool system were devised, as were responsibilities for user manuals and other documentation. The ruling document is now a part of the 'Level 1 ruling documents', meaning that it is valid for all departments of the hospital and is approved by the administrating director.

The document first existed on paper only. But after moving into new buildings, the hospital set up an intranet and after a period of coexisting on both paper and electronically the document now is found on the intranet only.

When the pool system started, we bought two different monitors. The first one is small, meant for standard bed-wards and for transportation. The second is bigger, meant for intensive care units (ICU) and anaesthesia purposes. It also fits onto the anaesthesia machine in use in our hospital.

Number of items before and after the start of the pool

It was decided to buy all types of accessories centrally, preferably only once a year (Table 1).

Each department elected one or several contact persons to serve as a link for the pool system. These contact persons are on a mailing list and are invited to meetings arranged for members of the pool system.

There were two storerooms for the pool. One was situated close to the ICU and was open at all times. It contained all items that were available in the system. The other was within the CED and was closed outside working hours. Staff looking for equipment go to one of these places and pick up what they need, or send a porter to fetch it. No signature or paper record is required, as it is assumed that staff-needing equipment are in a hurry.

In a hospital as big as Rikshospitalet, it was impossible to keep detailed track of where equipment was. Pieces of equipment may even have left the hospital without our knowledge. For instance, it was suspected that pumps disappeared out of the hospital from time to time. Mainly this happened in ambulances leaving the hospital with a patient. The next car coming in normally returned it.

A tracking system was piloted, where an ultrasound tag sent out a signal every time an object was moved. Receivers placed around in the building picked up this signal. It was then possible to see via a PC where objects had last been moved. This system worked well, but needed a lot of installation work in order to function. It could help in locating equipment, but in the end we decided not to install it. It was found that nothing can replace a person walking around in the wards, talking to staff, helping out and solving minor problems on the run and in general giving a friendly face to something as dull as standard equipment.

In CED a progress-based logistics system has been used since 1991. Here, all activity around all medical equipment is logged. Every item entering the hospital is issued its own unique number. From this base all repairs done are logged, hours and parts used, etc. until the equipment is taken out of use. All statistics presented comes from this database.

In January–February 2004 an evaluation of the pool was performed. Nine departments of different sizes, different disciplines, different needs and with different distances from the storerooms were selected. From the total of 397 names from these departments, including all categories of personnel, 219 people were chosen at random, in numbers corresponding to the size of each department. A standard data-based random function was used for this.

The questionnaire was sent out individually by mail. Two reminders were sent by e-mail. The allowed time for response was 4 weeks (about 122 people answered).

Table 1
Number of items before and after the start of the pool

Type	*Number before the pool (1998)*	*Number in the pool (2002)*
Monitors, transportable	65	302
Infusion pumps	354	387
Syringe pumps	312	404

Purchasing cost of pool equipment (2002): 32.5 million NOK.

Results

Results of the evaluation done in February/March 2004

The primary measure of success of the pool was customer satisfaction. Only 2% did not think that the pool system was good (Table 2).

Table 2
Results of an evaluation done in February/March 2004 ($n = 122$, 56% answered)

All numbers in %	*Yes*	*No*	*No answer*		
Are you familiar with our equipment pool system?	84	13	2		
Does your department use the pool equipment?	84	3	12		
Does your department have enough infusion pumps?	71	21	7		
Does your department have enough syringe pumps?	70	20	9		
Does your department have enough monitors?	87	5	8		
Does your department have enough accessories for monitors?	78	13	9		
Do you know the equipment pool storeroom?	68	25	7		
Do you believe contamination risk is bigger with the pool system?	34	59	7		
	Never	Seldom	Sometimes	Often	No answer
Do you find what you need in the storeroom?	0	2	6	56	37
	Very good	Good	Bad	Very bad	No answer
Do you believe the pool system is good?	26	59	2	0	13
The pool system gives standardization, is this good?	27	64	2	0	7
Is the service from Clinical Engineering Department (CED) good?	30	61	0	0	9
	Yes	No	Do not know	No answer	
Do you believe that the pool system is economical for the hospital?	61	1	34	5	
Do you believe that nursing care is better when using pool equipment?	55	10	32	3	
Does your department utilize pool equipment well?	62	1	30	7	

The evaluation showed that 55% of the staff believed nursing care was better when using the pool system. Also, 61% believed that the system was economical for the hospital and 62% believed that the pool equipment was utilized well in their department.

The evaluation showed that staff furthest away from the storerooms were less pleased with the pool, doctors and teachers did not know of the pool system at all. About 84% used pool equipment and more than 70% had enough equipment.

On the negative side, 34% believed that the contamination risk was bigger with the pool system, suggesting that this needs investigation.

The system has now eliminated a number of problems commonly experienced before. These problems were typically, a lack of equipment when it was needed, the wrong type of equipment found, the items that could be found were out of order or too dirty to be put to use directly.

Number of sets/pump/year

Another measure of success is economic. As shown in Figure 1, each type of pump has been used more and more since the pool started. The curve representing the small infusion pump drops significantly between 2001 and 2002. This has two reasons; the staff were advised not to use infusion pumps at a very low rate, but to use syringe pumps instead, and that we bought a number of these infusion pumps that year.

When a piece of equipment is delivered for repair, an identical piece is delivered to the user immediately.

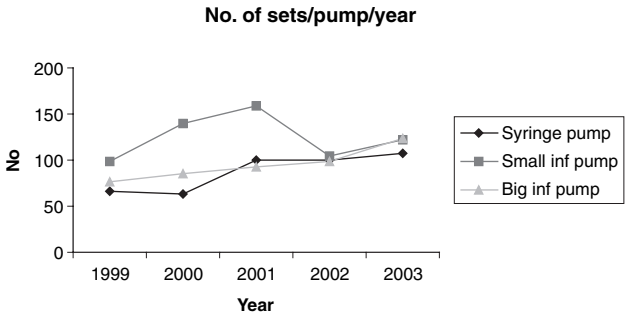

Figure 1
Number of sets/pump/year.

There is no waiting time for a repair and thus no stop in production because of equipment breakdown.

When the pool system was started, the departments ordered all types of disposables from the central store, also one-patient oximeter probes, while the CED provided all other accessories, including standard oximeter probes. It was found that several departments misused the readily available standard probes, so the CED now purchase one-patient oximeter probes. As CED buy all the disposables and also all the accessories for the monitoring system, only four to five invoices per year are generated. Before the start of the pool, 30 different departments bought these sensors and accessories like electrocardiographic (ECG)-cables, blood pressure cuffs, etc. This generated an estimated 1200 invoices per year. A conservative estimate is that the cost of handling one invoice in an organization of this size is 900 NOK. This means a cost reduction of 1 million NOK/year.

In addition to this, a lower price could be negotiated for the products because the companies put less work into deliveries and invoicing.

All pool pumps utilize standard power cables. After having run the pool system for some time, it was decided to transport patients connected to pumps without bringing power cables. This is possible because all pumps run for some time on batteries. As a result, a lot of equipment is now transported without cables. To avoid missing power cables stopping equipment being put to use, we have bought enough to satisfy all needs.

The fact that now only three kinds of pumps are in use, whereas before the pool started a total of eight different kinds were used, means that we now buy and store fewer types of infusion sets. It is easy to see that this saves space and money, but the exact amount is hard to quantify.

With the logistics system, maintenance data from as far back as 1991 can be found for all our equipment. Maintenance cost data from 1997 to 2003 for monitors and pumps is shown in Figure 2. It is however, difficult to conclude with certainty whether the pool system is cheaper to maintain than before the pool started. So much equipment was purchased during this period and it was not all put to use at once. The pool was established during the last part of 1999 but was not fully operational until after the move into new buildings in 2000. The equipment used before 1999 was quite old. It is also suspected that costs for 1997 are incorrect, therefore the cost/pump is too low for this year. The cost of maintaining the monitors went up in 2001 and 2002 due to end of guarantee from the manufacturer.

Our conclusion is that maintenance does not cost more for a pool although the equipment is used more with such a system.

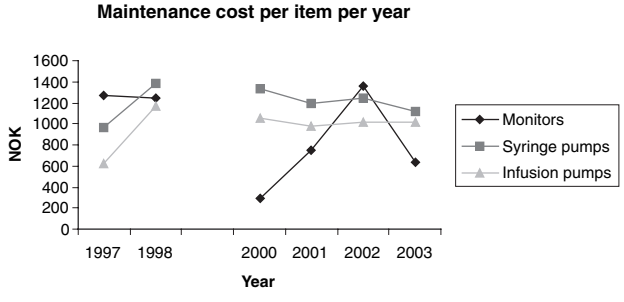

Figure 2
Maintenance cost per item per year. Due to the great variation in the value of Euro, from NOK 7.8 to 8.7, we use NOK as currency.

Maintenance cost for monitors and pumps

We conclude that the pumps do not cost more to maintain even though they have been used more since the start of the pool.

Because of standardization, the number of spare parts we have to store has been reduced, and less time is used per job.

Data also show that 33% of the total number of errors detected on syringe pumps in 2003 were because of mistreatment in some form and 12% were preventive maintenance.

The CED evaluated preventive maintenance on pumps and monitors. All the pool equipment receives such maintenance. This maintenance is done in house. Even though the pool equipment is put to a lot of stress because of the way it is used, CED is able to handle the amount of work involved.

The outcome of the attempts at a total standardization was that only two of 21 departments, using mostly stationary monitors, decided to buy another type to that in the pool.

Apart from one type of pump used only by the Anaesthesia Department, the pumps are identical throughout the Hospital. There are around 30 departments using the equipment pool, anaesthesiology being the largest.

When starting the pool, there was no understanding of the workload of teaching all necessary personnel the use of pool equipment. At the time of the large equipment deliveries, the companies provided standard training for our staff. Today the coordinator does most of the teaching for the equipment in the pool, which amounts to around 150 h/year. The rest is done by other staff from CED. Teaching is a very important part of running a pool and must be allocated enough resources.

From the start of the planning period of the new hospital in 1990 until the actual move in 2000, a number of conditions changed resulting in different departmental use of equipment. For instance, the Eye-department gave up all their monitors. These were eventually moved to an area for day patient care that was not in the original plan at all.

As the pool system allows every item to be accounted for, it is very easy to move monitors from one department to another when the need arises, without any extra cost to the hospital.

Since the move into new buildings in May 2000, we have relocated around 35 of 300 monitors.

Selecting suitable equipment for a pool system is different from looking for equipment for ordinary use. When items are allowed to travel all over the hospital, it is very important that they do not have removable parts

like dedicated power cables and fastening clamps that can come off and may be lost, rendering the equipment impossible to use when needed.

Several requests from staff have been received to include equipment like automatic pressure irrigation cuffs and blood warmers in the pool. This is seen as a measure of success.

From the start, the pool system was organized as a project and the coordinator did not have a permanent position with the hospital. Late in 2000 an administrative evaluation of the system was undertaken. Participating departments evaluated that the pool had been a success and that it had a further potential; and it was therefore made permanent.

Discussion

Pumps and monitors constitute the two largest patient equipment groups in our hospital. The main problem was too many different types of equipment presenting primarily a safety risk. Infusion devices are often the cause of unwanted incidents and even more so when there are a number of different devices to handle and patients need to be disconnected for transfer between wards. Another disadvantage was a large number of disposables requiring large storage space. Standardizing all equipment that is frequently moved around in the hospital solved these problems, but our experience is that a full standardization is hard to maintain.

When it was planned to extend the pool, the two models of monitors had gone out of production. As a result, we had to buy other, slightly different models, items that utilize the same accessories as the ones already in stock. Thus, total standardization is broken and the users will need to adapt to small differences between monitors.

Also total standardization with syringe pumps is broken. About 36 items of a different kind were purchased because of changes to the design. These are now confined to one department, to ensure that all personnel are trained to use the equipment they are supplied with.

It is necessary to purchase a small amount of a new type of equipment as a start. In this way it is possible to test and evaluate the product before making a large investment. In our experience, at least 6–12 months of normal use is needed for validation, to ensure that the product works well in the local environment. This amount of time is also needed in order to test whether the product is technically sound enough for the extra stress generated by a pool system or not.

Running a standardized pool system requires either buying all items needed before the chosen model goes out of production or to lose the standardization. This is a serious problem and must be taken into consideration when a pool is planned. One possibility may be to take all possible precautions in the contract with the company who delivers the equipment.

Another possibility would be to set up a leasing contract like the ones many companies have for cars. This way one could replace all equipment at the same time and avoid breaking the standardization. Legally this may be a problem, and it will probably be quite costly.

Another problem is that a lot of equipment has limited possibilities for storing user profiles. It is quite common for ICU and neonatal departments to need different set ups. Equipment in the pool must be identical and thus familiar to all users. This is the only way to ensure patient safety.

The 'Level 1' ruling document was in place before we started the actual use of the system. The document has been revised several times and changed according to our experiences.

We think it is important to let the pool system be a dynamic mechanism, changing as circumstances change.

After moving into new buildings, the pool system was put into operation. This was not easy. All departments were in new locations, had partly new staff and new organization and a lot of other types of new equipment to get used to. However, the change of surrounding may also have eased the transition. When almost everything else is changing, it may be easier to introduce an extra change.

At the moment we are ready to extend the pool, and we have requests from our users as to which equipment to include, namely blood warmers and automatic pressure irrigation cuffs. We find this reasonable because both equipment types are used by a number of departments and wander around the hospital connected to the patient.

On the negative side it soon became obvious that the system did not work entirely as intended and as stated in the official documentation. The greatest difficulty was to make some of the departments return superfluous items to the pool storeroom. It turned out that departments employing dedicated staff for equipment management did return pumps and monitors to the storeroom successfully; other departments without such staff did not. After a trial period of about 6 months we concluded that the main responsibility for returning superfluous items is to be the coordinator's. This means that the coordinator walks all over the hospital during a week, picking up equipment.

Another negative issue is hygiene. When a piece of equipment does not belong to anybody, it is easier to

ignore the responsibility and thus not care for it as you would if it belonged to your department. We have had to approach some departments about their level of hygiene, and gradually the situation is getting better. Our evaluation showed that 59% of the staff do not believe this is a problem.

With our experience, we believe that it is important that the pool is not run by a clinical department, but by someone neutral. In our case, this happened by chance. It was the Anaesthesia Department who asked CED to do the organizing.

From a CEDs point of view, running the pool system involves us more in the clinical 'life' of a hospital which gives us a better understanding of day-to-day procedures in the different departments.

Another advantage is that teaching is done by the coordinator from CED. This way teaching is standardized, although it may be planned specially for certain departments. It is also a safeguard against misunderstandings being passed on within a department. We believe that this also gives the CED a better knowledge of various departments' different ways and needs.

We have shown that the pool equipment is used more now than it was when it started. This probably means that with a pool system, the hospital can manage with fewer items than if each department has its own equipment. The evaluation shows that the staff are happy with the pool system and time and frustration spent on searching for equipment has been reduced. We have also shown that the patient care is better with this system.

Nurses now know where to find equipment, they have a person to talk to when something is out of order, someone to train staff and to approach with wishes concerning problematic equipment areas.

We save money for the hospital by ordering accessories once a year instead of 30 departments placing orders several times a year. But this kind of money is hard to locate and use for something else. It is a saving but does not show up in a place that can be used for something else.

We have built a system that nurses and other staff have learned to trust. Logistically it now works the way it was intended. The whole issue of having basic equipment ready at hand is taken care of. We provide a high degree of service and we find that this is appreciated.

After 5 years of experience, we find that our biggest problem is getting information out to all employees. Despite e-mails, information letters and meetings it is impossible to reach them all. This needs to be taken into account in all our dealings.

The evaluation of the pool system was done by staff from CED. It is recognized that it is not optimal to evaluate ones own system. However, we have taken every possible precaution to avoid bias in our design of the evaluation.

Establishing a pool system was difficult and created frustration but looking back, we see that the thorough work done in planning has been vital to the success we see today.

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Appendix 1 A model for standardized equipment pool handling

1. Standardize the problem areas
2. Buy the right amount of equipment
3. Agree where to place the pool storeroom
4. Elect responsible personnel in every department
5. Involve everyone in setting down the rules
6. Choose a suitable coordinator(s)
7. Make people trust the system
8. Give adequate information in how to use the equipment

