Using the Delphi technique to determine the costs of routine hospital care

ABSTRACT

Objectives: There is growing awareness of the need to link clinical effectiveness with cost effectiveness. This study was part of a multi-centre randomised controlled trial examining the effects of perioperative oral nutritional supplementation, in patients undergoing elective moderate to major lower gastrointestinal surgery. The study ran between October 1998 and July 2001 at three UK centres. This study sought to quantify whether routine care such as regular changing of a wound dressing makes a considerable contribution to the resources consumed in a hospital stay.

Methods: The Delphi technique was used to quantify the resources used and the cost of providing routine postoperative patient care. Consumables used and time spent by nursing staff on routine care during the trial were identified. The Delphi technique is a qualitative method for obtaining a consensus from individuals to address a question on which there exists some uncertainty. Two rounds of the questionnaire used in the Delphi were sent to participating nurses at the participating hospitals, to establish the number of consumables and time spent on each task.

Results: Consensus improved between rounds 1 and 2. There was a reduction in variability across the high and low values reported by the group, resulting in a broad level of agreement. The paper presents the resources used in terms of consumables and time and the associated costs in 2002 prices.

Conclusions: The study enabled the cost structure of frequently performed tasks to be expressed in a transparent form, allowing a more fulsome picture to be established of resource costs incurred by a hospital. Routine tasks may be difficult to quantify, but make a substantial contribution to the costs of a hospital in terms of the volume of patients they affect.

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INTRODUCTION

There are increasing pressures on health care resources, as populations grow and new technologies are developed. New interventions are closely studied rather more than existing and everyday care. Routine care can be difficult to quantify and its contribution often neglected and overlooked in hospital costs. The impact on elective inpatient care can however be substantial. Routine care is given to most patients who enter the hospital system therefore a large volume of patients. Regular, small events may thus have significant cost implications and may be important contributors to true intervention costs and consequences. If such care is avoidable they can represent a cost saving to the hospital.

With increasing pressure on healthcare resources, it is imperative to consider the true costs of care. Routine tasks such as administering intravenous medications and changing wound dressings may not take long to undertake, but if they have to be repeated several times a day, the resources consumed become substantial. These routine tasks are not usually quantified and as such costs for these tasks are not normally available. Instead they are given an average apportionment in total ward costs. Although routine care is likely to be provided at small cost to the hospital, the intervention itself, at 0.31 per carton of *Fortisip* (Nutricia, Zoetermeer, The Netherlands), (UHNS contract price) is a low cost intervention. Therefore the intervention cost is likely to be offset by any potential savings available from reductions in routine care.

Nurses provide this routine care and are the crucial group to assist in quantifying such care. The approach used in this work was to build up a resource profile for the tasks undertaken using the Delphi technique to draw on the experience of nurses. This then enabled associated costs to be assigned.

This study focussed on the use of a qualitative method, the Delphi technique[1] to quantify the resources attributable to post-operative routine surgical care. Where quantitative data are not available routinely, alternative methods must be employed to collect such data. A way of obtaining this data is through qualitative techniques such as the Delphi.

A number of methods were considered to quantify such routine care. These included observing nurses practice; nominal group techniques; shadow pricing and using an average apportionment. The Delphi was considered to be the most suited to this study where participants were spread across a number of sites, equal weighting of participants was desirable and the authors were seeking both to improve quantification of such tasks without imposing an intrusive burden upon the nurses in the study.

The work quantified natural resource units, i.e. actual physical resources consumed, rather than directly reporting cost. The quantification and reporting of the natural unit allowed the findings of the research to be transparent.

This work was done as part of a multi-centre randomised controlled trial (RCT) that examined the effects of perioperative oral nutritional supplementation (ONS) *Fortisip* (Nutricia, Zoetermeer, The Netherlands), in patients undergoing elective moderate to major lower gastrointestinal surgery [2]. A systematic review of evidence has shown giving ONS to certain groups of hospitalised patients improves clinical outcome[3]. The study ran between October 1998 and July 2001 at three UK centres: University Hospital of North Staffordshire (UHNS), Central Middlesex (CM) and Chelsea and Westminster (C&W) NHS Trusts. The full

economic paper will be reported elsewhere, this paper reports the results of the Delphi exercise only.

The Delphi Technique

The Delphi technique, developed by the RAND Corporation in the 1950s, is one of several methods for obtaining a consensus from a number of individuals to address a question on which there exists some uncertainty[1,4,5,6,7,8,9]. An expert panel is chosen comprising individuals who have knowledge and understanding of the issues concerned. Several rounds of the Delphi questionnaire are sent to the expert panel anonymously. Controlled group feedback is given with each round of the questionnaire, but the panel never meet.

There are four features that define the Delphi technique[10]. These are 'anonymity, iteration, controlled feedback, and statistical aggregation of group response'. Anonymity allows participants to express their views freely, away from social pressures, and is achieved through the use of postal questionnaires. Iteration occurs since the questionnaire is sent out more than once, allowing participants to revise their opinions. Controlled feedback occurs between the rounds. Responses from each participant contribute equally to a summary statistic which is fed back to participants after each round. The statistical aggregation from the last round of responses forms the final group opinion. The measure of spread calculated provides an indication of the level of agreement in the group.

Although the Delphi technique is often used to inform the detail surrounding patterns of care or treatment choices, it is less frequently used to determine the resource profile of care. Where resources or consequences of care have been determined by the Delphi, they have been used as an alternative approach to establish the whole resource package, hence the Delphi has been used as a substitute for collecting resource or cost data[11,12,13]. In this study it has not substituted routine data collection, but supplemented such information to build up more detailed resource package. Hence the Delphi has been used to obtain accurate and detailed information surrounding common elements of patient care.

This paper focuses on tasks that form routine care for patients in hospital. It demonstrates the use of two rounds of a Delphi technique to quantify such tasks. Some of the problems with such an exercise are illustrated, as are ways in which they may be overcome. It presents the results of the Delphi in terms of resource use and healthcare costs. The results obtained can be applied to a local setting, using local costs to build up a local cost picture for each of the tasks. Finally, the paper presents a discussion regarding the use of the Delphi and the usefulness and application of the data delivered by this exercise.

METHODS

The Delphi technique was used to obtain a consensus on the amount of consumables and nursing staff time required to perform routine tasks. Guidelines on the conduct and reporting of studies using the Delphi technique can be found elsewhere[14]. As part of the RCT, the number of days patients had routine care such as the administration of intravenous fluids, use of catheters and dressings was recorded.

Tasks

A monitoring team was established comprising of a consultant gastroenterologist, dieticians, nurses from the participating centres and the authors. This team determined the initial list of routine tasks and items within each task. These were then validated by nurses at the UHNS. This study did not attempt to quantify all tasks but concentrated upon a group of frequently performed tasks (see Table 1) for surgical gastrointestinal patients for example wound dressing and continence control.

Expert Panel

Those who deliver the care are in the best position to estimate the resources used. In this case it was nurses on the surgical wards at the participating hospitals who had the most knowledge about this group of patients and the tasks performed. Senior nurses from each ward were selected to participate in this study by the ward sister. These nurses therefore made up the expert panel.

The numbers of patients recruited to the trial at each hospital were used to influence the number of nurses from each hospital participating in this study. In total 20 nurses were selected to participate, 10 from UHNS, 3 from CM, and 7 from C&W.

Designing the questionnaire

Each common task formed a section on the initial questionnaire. Individual consumables needed for each task were detailed, and participants were asked to estimate the lifespan of each item. Within the section for drainage of a wound, for example, a wide bore drain, a drainage bag, dressing and gloves and apron were identified. The questionnaire asked respondents to estimate the lifespan of each item, i.e. how many days can a wide bore drain be used before it requires replacement? For consumables used more frequently, such as gloves, the respondent could estimate the number used per day. There was a box for any additional comments.

The items used for the various tasks were stated for the first round and opinions gathered regarding the quantities and the times associated with each item. It was intended that any items missed would be picked up at validation. Since two rounds only of the Delphi were planned due to time constraints, it was important to place the emphasis on quantifying a given list of consumables, and their associated times.

The covering letter with the questionnaire explained the background to the exercise and asked that participants identified the consumables and time associated with each of the tasks in Table 1. It was crucial that the thinking was clearly explained in this letter as the monitoring

team would not meet the participants, or have further opportunity to explain their intentions unless participants sought clarification.

Validating the questionnaire

A consultant gastroenterologist, two dieticians and two experienced nurses validated the questionnaire with the aim of ensuring that the list was complete and covered all the appropriate tasks. It ensured that the wording of the questionnaire and the covering letter were clear and easy to understand. The round 1 questionnaire was then produced. A completed example section is shown in Table 2.

Calculating Resource Costs

The Delphi provided a best estimate of the number of consumables and the length of time associated with each item, by task. This information on resource use was then used to calculate the costs of these tasks. All costs are presented in pounds sterling with 2002 as the base year. Cost sources were inflated to the base year where appropriate. The total cost per episode was split into consumable costs and time costs. Each of these components is now considered, with examples presented for the purposes of illustration only.

Consumable Costs

Several steps were required to determine the total consumable costs per episode. Costs of consumable items were obtained from the NHS[15]. The number of consumable items was multiplied by the cost per item to give the cost incurred within the stated time period for each item. Having determined costs for each item, two summary component costs for each task were computed. These were a cost per day, and a fixed cost per episode. The cost of all consumables measured per day were added together as were all those fixed per episode. The total consumable cost per episode consisted of a fixed one-off cost per episode and a cost per day of that task.

If a patient had 5 days of epidural analgesia, the consumable cost would be a fixed episode consumable cost (for items such as the extension lead), added to a daily cost (for syringes etc) multiplied by 5. If the fixed consumable cost was £10, and the daily cost £1, then the consumable cost of a 5-day episode of epidural analgesia would be £15.

Nursing Time Costs

Within each task the time associated with each item was attributed per day, per item, fixed per episode or occasionally split into two components: insertion and checking, or a time per whole task. Times measured per item were converted into times per day by multiplying by the number of items used per day. All the times were multiplied by the unit cost per minute of a nurse's time, based on the salary of a D grade nurse at UHNS with overheads, and taking the midpoint of this salary (£18,987). This yielded a cost per minute for nursing time of £0.20. The time cost of all elements of a task measured per day was totalled, and similarly all elements fixed per episode.

If a wound was cleaned and then dressed for 5 days: 10 minutes were spent cleaning the wound initially, and then a further 5 minutes each day to dress it. The fixed time

cost for this episode for the cleaning was £2 and the daily cost was £1, so the total time cost for the complete episode would be £7.

There were a few items where the time component was split into two elements: time to insert and time to check per day. These two components were used for cannulae, catheters and central venous pressure (CVP) lines. These items require a one-off insertion time, and then regular monitoring each day, hence it was necessary to record these two times separately.

Total Resource Costs

Since the number of days these common tasks were performed for each patient was recorded in the RCT, it was possible to calculate the resource use and associated costs. Where patients had an event, for example a wound infection, the fixed cost incurred for consumables and time was included. The length of the episode was used to calculate the total additional cost of consumables and time incurred daily. If patients had more than one episode, these were recorded separately, as the fixed costs would be incurred more than once.

Tasks where a total time was recorded

For a few tasks nurses recorded a time for the whole task, rather than allocating time spent to each item used within the task. A whole task time was used for administering intravenous, intramuscular and rectal medications, and blood. After round 1, the nurses were not asked to record the consumables required for these tasks again. There was agreement that 1 of each consumable was required each time. The differences in responses for intramuscular medications for example, related to the number of doses per day that nurses assumed patients required. Since it was not necessary to detail all the consumables for these tasks for round 2, nurses were asked for a whole task time.

Analysis of Delphi Round 1

The questionnaire was sent to 20 nurses. Table 2 shows the patient controlled analgesia (PCA) section completed by participant number 1. The results of round 1 were input into Microsoft Excel, and for each item the median value was calculated. To give an estimate of the variation in answers amongst respondents, the interquartile range was also calculated. The group median and upper and lower quartile values, together with the respondent's own score were fed back in round 2. These can be seen for participant number 1 in Table 3. The median is labelled as "average", as it was felt that respondents would more easily understand this term. Similarly, the upper and lower bounds of the interquartile range are labelled "high" and "low".

Several measures of central tendency were considered and the median was chosen as most appropriate. Some respondents gave extreme values. It was felt that such values were a consequence of misinterpreting the question, rather than true variations in practice. The median is not influenced by extreme high or low values, hence, it was considered a better reflection of the "true" group value[16]. The interquartile range was chosen for similar reasons. The median and interquartile ranges were used in all data analysis.

Modifying the Questionnaire: Quantifying consumables and nurses' time

Some aspects of the questionnaire were changed in round 2, as a consequence of feedback received from round 1. Some items became unnecessary, for example the grade of nurse required to perform a task. In round 1 almost all respondents suggested that all grades of nurse performed each task. It was decided to assign a mid scale D grade nurse for costing purposes rather than ask the question again.

The most important change related to the units of measurement for consumables and times for each item, which were not defined clearly enough in round 1, causing difficulties in aggregation. In round 1, for example, several responses to the number of cannulae needed for intravenous (IV) fluids were 1 per day, and 1 per patient. Since these are in different units, it is difficult to combine these responses. For round 2, it was specified that consumables were measured either per day, or per episode, rather than allowing the respondent to specify the units. Times were measured per day, per item or per episode. A few items were split in terms of time into two components: insertion and checking, and a few times were quantified for the whole task. This did not constitute a major change to the questionnaire but a clarification to assist ease of reporting and analysis.

The covering letter for round 2 was more detailed. It addressed issues and problems surrounding completion in round 1 whilst reiterating the overall messages of the first letter. As well as detailed completion instructions for round 2, the reason for each of the steps and how the information provided would be analysed was included. Both letters stressed confidentiality and anonymity.

The results of round 1 and the second round questionnaire were fed back to all participants of the Delphi regardless of whether the first round questionnaire was returned.

Analysis of Round 2

The responses to the second round questionnaire were analysed in the same way as the first round; the medians and interquartile ranges were calculated. These results were fed back to participants for information only. Final results were compared with those from round 1 to look at the change in the estimates over the two rounds. The median values from the final results were compared with their interquartile ranges to investigate the level of consensus reached.

RESULTS

Analysis of Round 1

From the original 20 questionnaires sent out, 13 (65%) were completed, 9/10 from UHNS 3/3 from CM and 1/7 from C&W. The results from round 1 were fed back in the form of a revised template. The PCA section of the second round questionnaire based on these results is shown in Table 3. The original estimates of participant number 1 from round 1 are shown, together with the group median ("average") and the group interquartile range, ("low" and "high") from round 1. The participant was asked to review his/her original estimates in the light of the group information.

Analysis of Round 2

Of a possible 20 responses, 7 (35%) of the questionnaires were returned. Apart from one these were all from nurses who had responded to round 1. The respective returns were 5 from UHNS, 1 from CM and 1 from C&W

An indication of the changes of opinion between rounds 1 and 2 can be seen in Table 4. It shows that there were subtle changes in the median values of estimates, but that the variation in responses reduced. The interquartile range remained similar where there was already a high level of agreement among respondents, for example on the number of stoma bags used; otherwise it virtually always reduced for example the time associated with care of a wide bore drain.

Table 4 provides an illustration of the results from rounds 1 and 2. It shows that on the whole the median remained the same, or reduced slightly, for example time per day to maintain a drainage bag reduced from 15, to 10 minutes. This was true across all categories. There was a reduction in variability across the high and low values reported by the group. Consensus improved between rounds 1 and 2. Time ranges in round 1 were particularly broad. A time per day of between 5 and 45 minutes was reported for the management of a wide bore drain, whereas by round 2 this had reduced to between 5 and 15 minutes. This illustrates a consistent and better understanding of the question posed in the Delphi questionnaire by the nurses. Such an exercise further helps the individual to focus more clearly and systematically on the task under consideration.

Resource Use

The median values for resource use from the second round of the Delphi can be seen in Table 5. For each item in each task, the consumable usage and the time associated are detailed, both split into the different recording time periods.

Resource Costs

The resource costs are shown in Table 6. The cost for consumables was determined by multiplying the quantity used for each consumable (Table 5) by the cost per item. Table 6 further shows the nursing time costs associated with each item. In patient controlled analgesia, epidural analgesia and CVP line, insertion was undertaken in theatre therefore the associated time was not costed.

Total Resource Costs

Table 6 shows the costs of consumables and nursing care for each item in each task, and totals for each task. There was a choice for some of the items used in the tasks for example for drainage; either a drainage bag or a stoma bag was used for a wound drain. Hence there were several options for calculating summary component costs for each task. The summary consumable and time components of cost for each different option are shown in the "totals" for each task in Table 6. Since the estimates for resource use for consumables and time for male and female catheters were exactly the same, these have been grouped together. Where all items were used in the task, there is one set of summary costs labelled "Total".

The summary components provided enough information to cost an episode of care. Table 7 shows these summary components of total cost for each task. For example, if a patient had a wound drain for 5 days using a drainage bag, then the cost of the episode could be calculated. The consumable costs comprised a fixed cost of £6.64 and 5 daily costs of £0.73: £10.29 in total. The nursing time cost consisted of a fixed cost of £1.01 and 5 daily costs of £4.42: £23.11 in all. Hence the total cost of the placement and management of a wound drain for 5 days was £33.40.

Table 8 enables direct comparison to be made for each task in terms of average length of episode, and consumables, staff and total cost. It can be seen from Table 8 that costs for each individual task per average episode vary from £15.60 to £104.72. Table 9 presents the resources and costs for those tasks where total costs were attributed.

DISCUSSION

Routine care forms a significant part of the care a patient receives in hospital and hence the costs of an inpatient stay. This study has attempted to quantify in detail inputs in terms of consumables and nursing staff time, and hence cost the contribution to overall resource use of these everyday tasks. Although undertaken in a UK context, by expressing the care received by the patient into deliverable tasks and hence consumables and time, the findings may be translated into any setting either national or international.

The work is reported in natural units that are real resources consumed as well as cost. Natural units are the most useful level of reporting in terms of economics. Cost alone disguises the real resources used in an intervention, reflecting the pay and prices of an individual country. Results reported in natural units may be interpreted in a local context by comparing the pattern of care presented here with local patterns of care and local cost structures.

Although the identification and costing of routine care is seemingly a quantitative process with quantitative applications, this paper has demonstrated the important role qualitative methods can play in defining these inputs. Such tasks and their inputs are not recorded routinely by quantitative systems hence prior to this work there was no accurate way to assign the amount of resource and the cost to the health service that they represented. Where quantitative data is not available routinely, qualitative research may have a complementary role to play in the construction of such data.

The results obtained from this study in terms of valuing routine care are largely quantitative in nature. Costs for routine tasks were not available from routine datasets and it was necessary to elicit the views of the service deliverers to get a picture of the real resources involved in routine care. This study has therefore used a qualitative technique – the Delphi to answer quantitative questions. This method for this work is essentially qualitative capturing the participants views of the consumables and time involved in delivering routine care. Using the Delphi technique enabled this to be done in non-threatening and anonymous way for the participants and gave them control over the data and their answers, rather than collecting the information in a potentially threatening and quantitative manner by using techniques such as direct observation.

An important element of this work was the choice of the tasks covered by the Delphi. The tasks selected reflect those undertaken in the routine care and treatment of many patient groups, not just surgical gastroenterology. Many surgical groups require wound dressings or assistance with continence. Hence, the tasks chosen for quantification and remuneration in this analysis are generally applicable across a whole range of conditions and specialties; they are not just highly specialised tasks. It is these common tasks that are often neglected in evaluations that have a more specific focus evaluating a new procedure or piece of technology, yet such tasks contribute to much of the healthcare provided and resources utilised in a hospital setting.

Table 8 shows routine care is provided for a relatively small cost per individual intervention for example £18 to care for a redivac wound drain. These frequently performed tasks may be small in terms of their actual cost per patient, but may affect a large number of patients, therefore imposing a substantial resource burden upon the ward and the hospital. Other elements of routine care are more expensive for example care of an infected wound is £105 for an 8-day treatment episode. Avoiding such complications and the need to undertake such a

task would result in direct resource savings both in terms of consumables and staff time. Even though relatively small in cost routine interventions are still considerably more expensive than a course of nutritional supplementation if for example, a patient was on two cartons a day for 12 days the cost of an episode of care would only be and episode of care would only be £7.44.

Breaking each task down into specific components enabled the fixed element of each task to be separated from the variable element. Certain tasks must always be performed at the start of an episode. Others depend upon how long that episode lasts and may be performed on a daily basis. Splitting costs into the fixed and variable elements allows savings from reducing the severity or duration of an event or changing practice to be clearly identified. If a wound drain can be removed earlier in the treatment regimen for example, the fixed element of costs are still incurred for example the drain itself, but savings can be made from the variable element which are identifiable and realisable, for example daily drain dressings.

The split between consumable and staff costs is highlighted in Table 8. Staff costs are often a large resource driver; however, consumables are a significant cost driver for stoma care and use of CVP lines. In the tasks studied, immediate savings can be made from consumables if the requirement for routine task could be reduced. Longer-term savings and redistribution can be made from savings in staff time. Wound infection is both a high consumer of staff and consumables; hence a reduction in infections would represent considerable savings to the hospital. Implementing interventions such as the provision of oral nutritional supplements that can improve patients' clinical outcome, may reduce complications and the need for routine tasks, hence result in resource and cost savings for the hospital.

Although reductions in routine care required represent savings in financial resources they also have an opportunity cost attached in terms of the nursing time involved. If nurses for example could reduce the number of days on a wound drain by one day, or prevent one infected wound, time savings in the order of 40 minutes per day could be achieved (see Table 5). Such time could have alternative uses such as there being greater time available to talk to and counsel the patient or their relatives.

The Delphi technique is labour intensive in terms of researchers' time in its design and analysis. However, it is considerably less costly than employing a researcher to monitor the behaviour of the same number of individuals' (observation studies). It is less costly to run in terms of resources and participant time than a nominal group technique. The Delphi is more sensitive to the views of the individual than shadow pricing or average apportionment.

One of the key benefits of the Delphi and this study is that it has enabled a more fulsome picture of the cost structure of frequently performed tasks to be expressed in a transparent form. The breakdown of costs shows that these small, but regular resource inputs, can be a considerable burden upon the costs of the ward, nursing staff and ultimately to the hospital. Costs of frequently performed tasks are often neglected in the analysis of treatments and procedures. The results presented here illustrate the peril of ignoring such tasks in terms of the true overall resource and cost picture.

Rowe [10] referred to the four characteristics of the Delphi as anonymity, iteration, controlled feedback and statistical aggregation. All have been important in undertaking this exercise. In round 1 no individual was influenced by another's answers as the questionnaires were sent independently to each participant. The divergence of the results for round 1 would support the belief that although a number of the nurses did indeed work in the same hospital, they did not

confer regarding their answers to round 1. The iterative rounds then assisted the individual in examining their own practice. It gave respondents the chance to modify any answer they may have given without implying a right or wrong answer or displaying their individual answer to their colleagues. The feedback was only given to the participants of the study, hence was controlled and at no point was an individual's manager given access to this information. The analyst was blinded to the actual identity of the individuals who were known only by their participation numbers.

The Delphi technique enables participants to maintain both their independence and their anonymity. Watching and monitoring somebody can be seen as a threatening activity to the individual and they may feel a lack of control in the process. The very nature of watching someone may cause them to change their behaviour - the Hawthorne effect. It is rarely sustainable and hence results obtained in such a fashion can distort reality and the long-term picture. The Delphi asks the professional concerned to provide their own values for tasks they perform regularly.

Black[4] stated that reliability declines rapidly below six respondents. In this study, participation was just above six with seven nurses responding to both rounds of the questionnaire. Although disappointing, this included responses from nurses at each of the three participating sites. The centres used in this study reflect both a medium sized district general London hospital - the CM, a London teaching hospital – the C&W and a large non-London city hospital – the UHNS, which was not a teaching hospital at the time of the study. Agreement of individuals across sites facilitates the transferability of the findings presented within this paper to other hospitals.

This analysis identified key tasks rather than attempting to quantify all the tasks associated with routine hospital care. There is no reason to suppose that these key tasks would be dissimilar across other hospitals. Other studies may wish expand on this list of tasks and apply the methods described here to quantify consumables and staff time.

CONCLUSIONS

Routine hospital care is difficult to quantify, but can make a significant contribution to the costs of a hospital. When undertaking economic appraisal the contribution of routine care is often neglected. This work has used a qualitative method the Delphi technique to quantify routine tasks. It has identified the contribution they make to hospital resource use and hence cost. Interventions such as oral nutritional supplements that can reduce the number and severity of routine tasks performed, may result in resource and cost savings for the hospital. The study has illustrated the usefulness of the Delphi in quantifying routine care.

Full word count 5,329

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Table 1: Tasks covered by the Delphi

Patient controlled analgesia (PCA)
Epidural analgesia
Intravenous (IV) fluids
Intravenous, intramuscular, subcutaneous and rectal medications
Standard and vacuum wound drains
Stoma care
Dressings for infected and non-infected wounds
Urinary catheters
Anti-Embolism (TED) stockings
Blood administration
Central venous pressure (CVP) line care

Table 2: The patient controlled analgesia section from the round 1 questionnaire completed by participant number 1

Task	**Item**	**Usual nurse grade that looks after this task**	**Length of time** (Please indicate – in minutes – time spent per patient per day looking after this task)	**Lifespan** Please indicate units used (i.e. number per day, or one per X days)	**Comments**
Patient controlled analgesia	50ml luer lock syringe	D/E/F/G	60 mins	3 per day	
	Extension lead	D/E/F/G	3 mins	1 per day	
	Cannula	D/E/F/G	10 mins	1/2 per day	
	IV dressing	D/E/F/G	2 mins	1/2 per day	
	Sterile gloves & apron	D/E/F/G	2 mins		

Table 3: The patient controlled analgesia section of the round 2 questionnaire for participant number 1

TASK	ITEM	TIME PERIOD	1	AVERAGE	LOW	HIGH	NEW VALUE (if applicable)
PCA	50ml luer lock syringe	per day	3	2	1.25	2.5	
	Time (mins)	per item	20	15	8.5	25.25	
	Extension lead	per episode	1	1	1	1	
	Time (mins)	per episode	3	5	3.5	6.88	
	Cannula	per episode	1.5	0.4	0.33	1	
	Composite time (mins)		6.67	5.83	3	17.25	
	Time (mins)	per insertion					
	Time (mins)	per day (to check)					
	IV dressing	per day	1.5	1	0.5	1.5	
	Time (mins)	per item	1.33	5	1.83	16.25	
	Sterile gloves & apron	per day		3	1.5	4.5	
	Time (mins)	per item	2	3	1.67	9.29	

[a] All values are calculated to 2 decimal places; zero places not reported.

Table 4: Round 1 and 2 results for wound drain

TASK	ITEM	TIME PERIOD	ROUND 1			ROUND 2		
			AVERAGE	LOW	HIGH	AVERAGE	LOW	HIGH
Wound	Wide bore drain	per episode	1	1	1	1	1	1
drain	Time (mins)	per episode	5	2.17	45	5	5	15
	Drainage bag	per episode	1	1	1	1	1	1
	Time (mins)	per day	15	5	45	10	10	20
	Stoma bag (used for drainage)	per day	1	1	1.13	1	1	1
	Time (mins)	per day	20	5	30	20	7.5	25
	Drain dressing	per day	1	1	1.13	1	0.7	1
	Time (mins)	per day	10	5	30	10	9	10
	Gloves & apron	per day	2.5	1.25	5.38	2	1.2	2.75

Table 5: Resource use

TASK	ITEM	CONSUMABLES		TIME (MINUTES)			
		QUANTITY PER DAY	FIXED QUANTITY PER EPISODE	TIME PER INSERTION	TIME PER ITEM	TIME PER DAY	FIXED TIME PER EPISODE
Wound drain	Wide bore drain		1				5
	Drainage bag		1			10	
	Stoma bag (used for drainage)	1				20	
	Drain dressing	1				10	
	Gloves & apron	2			1		
Redivac wound drain	Redivac drain		1				5
	Redivac bottle		2				6
	Drain dressing	1				5	
	Sterile gloves & apron	2			1		
Urinary Catheterisation	Male catheter		1	20		5	
	Female catheter		1	20		5	
	Suprapubic catheter		1	15		6.5	
	Suprapubic catheter dressing	1			8		
	Hourly urine bag		1			24	
	Bedside urine bag		1			6	
	Gloves & apron	3			1		
Stoma care	Closed stoma bag	1.75				10	
	Open ileostomy bag	1				10	
	Open colostomy bag	1				10	
	Gloves & apron	2			1		
Non-infected wound	Vapour permiable dressing ('mepore')	1				5	
	Gauze squares	1			5		
	Gloves & apron	1			1		
Infected wound	Alginate dressing ('kaltostat')	1				12.5	
	Alginate packing ('Sorbsan ribbon')	1			5		
	Ribbon gauze	1			5		
	Antiseptic lotion ('proflavin')	1			10		
	Gloves & apron	1			1		
Patient controlled analgesia	50ml luer lock syringe	2			10		
	Extension lead		1				5
	Cannula		1	NOT INSERTED ON WARD		0.17	
	IV dressing	1			3		
	Sterile gloves & apron	1			1		
Epidural analgesia	50ml luer lock syringe	2			17.5		
	Extension lead		1				5
	Spinal cannula		1	NOT INSERTED ON WARD		2.42	
	IV dressing	1			2		
	Sterile gloves & apron	2			1		
CVP line care	CVP line		1	NOT INSERTED ON WARD		1	
	Dressing (tegaderm & cleanser)	1			3.5		
	Sterile gloves & apron	1			1		
Intravenous fluids	Cannula	0.5			6		
	Giving set	0.33			5		
	3 way tap	0.33			3		
	IV dressing	1			2.5		
	Swab	1			2.5		
	Sterile gloves & apron	2			1		
Anti - coagulation	TEDs (below knee)		1			5	
	Syringe	2			1.25		
	Needle	2			1.25		
	Swab	1			1.67		
	Gloves & apron	2			1		

Table 6: Resource costs

TASK	ITEM	CONSUMABLES		TIME		
		COST PER DAY (£)	FIXED COST PER EPISODE (£)	FIXED COST PER INSERTION (£)	COST PER DAY (£)	FIXED COST PER EPISODE (£)
Wound drain	Wide bore drain		5.93			1.01
	Drainage bag[a]		0.71		2.01	
	Stoma bag (used for drainage)[a]	2.32			4.02	
	Drain dressing	0.61			2.01	
	Gloves & apron	0.12			0.40	
Totals	*Drainage bag used for drainage*	*0.73*	*6.64*		*4.42*	*1.01*
	Stoma bag used for drainage	*3.05*	*5.93*		*6.43*	*1.01*
Redivac wound drain	Redivac drain		2.40			1.01
	Redivac bottle		4.80			1.21
	Drain dressing	0.61			1.01	
	Sterile gloves & apron	0.12			0.40	
Total	*All items*	*0.73*	*7.20*		*1.41*	*2.22*
Urinary Catheterisation	Male catheter[b]		0.68	4.02	1.01	
	Female catheter[b]		0.68	4.02	1.01	
	Suprapubic catheter[b]		5.52	3.02	1.31	
	Suprapubic catheter dressing	0.61			1.61	
	Hourly urine bag[c]		6.09		4.82	
	Bedside urine bag[c]		0.71		1.21	
	Gloves & apron	0.18			0.60	
Totals	*Male/Female catheter & hourly bag*	*0.18*	*6.77*	*4.02*	*6.43*	
	Male/Female catheter & bedside bag	*0.18*	*1.39*	*4.02*	*2.82*	
	Suprapubic catheter & hourly bag	*0.79*	*11.61*	*3.02*	*8.34*	
	Suprapubic catheter & bedside bag	*0.79*	*6.23*	*3.02*	*4.73*	
Stoma care	Closed stoma bag[d]	4.06			2.01	
	Open ileostomy bag[d]	2.63			2.01	
	Open colostomy bag[d]	2.28			2.01	
	Gloves & apron	0.12			0.40	
Totals	*Closed stoma bag*	*4.18*			*2.41*	
	Open ileostomy bag	*2.75*			*2.41*	
	Open colostomy bag	*2.40*			*2.41*	
Non-infected wound	Vapour permiable dressing ('mepore')	0.57			1.01	
	Gauze squares	0.05			1.01	
	Gloves & apron	0.06			0.20	
Total	*All items*	*0.68*			*2.22*	
Infected wound	Alginate dressing ('kaltostat')	3.26			2.51	
	Alginate packing ('Sorbsan ribbon')	1.78			1.01	
	Ribbon gauze	0.75			1.01	
	Antiseptic lotion ('proflavin')	0.50			2.01	
	Gloves & apron	0.06			0.20	
Total	*All items*	*6.35*			*6.74*	
Patient controlled analgesia	50ml luer lock syringe	0.68			4.02	
	Extension lead		2.06			1.01
	Cannula[e]		0.70		0.03	
	IV dressing	0.27			0.60	
	Sterile gloves & apron	0.24			0.20	
Total	*All items*	*1.19*	*2.76*		*4.85*	*1.01*
Epidural analgesia	50ml luer lock syringe	0.68			7.04	
	Extension lead		7.95			1.01
	Spinal cannula[e]		3.60		0.49	
	IV dressing	0.27			0.40	
	Sterile gloves & apron	0.48			0.40	
Total	*All items*	*1.43*	*11.55*		*8.33*	*1.01*
CVP line care	CVP line[e]		17.50		0.20	
	Dressing (tegaderm & cleanser)	0.27			0.70	
	Sterile gloves & apron	0.24			0.20	

Total	*All items*	*0.51*	*17.50*		*1.10*	
Intravenous	Cannula	0.35			0.60	
fluids	Giving set	1.32			0.34	
	3 way tap	0.28			0.02	
	IV dressing	1.00			0.50	
	Swab	0.01			0.50	
	Sterile gloves & apron	0.48			0.40	
Total	*All items*	*3.44*			*2.54*	
Anti -	TEDs (below knee)		3.48		1.01	
coagulation	Syringe	0.06			0.50	
	Needle	0.04			0.50	
	Swab	0.01			0.34	
	Gloves & apron	0.12			0.40	
Total	*All items*	*0.23*	*3.48*		*2.75*	

[a,b,c,d] Only one of these items used at any given time.
[e] Time costs are not included as item is inserted in theatre.

Table 7: Summary consumable and time component costs for each task

TASK	SCENARIO	CONSUMABLES			TIME	
		COST PER DAY (£)	FIXED COST PER EPISODE (£)	FIXED COST PER INSERTION (£)	COST PER DAY (£)	FIXED COST PER EPISODE (£)
Wound drain	Drainage bag used for drainage	0.73	6.64		4.42	1.01
Redivac wound drain	All items	0.73	7.20		1.41	2.22
Urinary catheterisation	Male/Female catheter & bedside bag	0.18	1.39	4.02	2.82	
Stoma care	Closed stoma bag	4.18			2.41	
Non-infected wound	All items	0.68			2.22	
Infected wound	All items	6.35			6.74	
Patient controlled analgesia	All items	1.19	2.76		4.85	1.01
Epidural analgesia	All items	1.43	11.55		8.33	1.01
CVP line care	All items	0.51	17.50		1.10	
Intravenous fluids	All items	3.44			2.54	
Anti - coagulation	All items	0.23	3.48		2.75	

Table 8: Estimates of total costs for routine tasks, based on average length of episodes in the study

TASK	AVERAGE LENGTH OF EPISODE (in days)	CONSUMABLE COST (£)	STAFF COST (£)	TOTAL COST PER EPISODE (£)
Wound drain	4	9.56	18.69	28.25
Redivac wound drain	4	10.12	7.86	17.98
Urinary catheterisation	5	2.29	18.12	20.41
Stoma care	12	50.16	28.92	79.08
Non-infected wound	7	4.76	15.54	20.30
Infected wound	8	50.80	53.92	104.72
Patient controlled analgesia	3	6.33	15.56	21.89
Epidural analgesia	3	15.84	26.00	41.84
CVP line care	4	19.54	4.40	23.94
Intravenous fluids	5	17.20	12.70	29.90
Anti – coagulation – TEDs only	12	3.48	12.12	15.60

Table 9: Time taken and cost for tasks where total time was measured

TASK	Total time to perform task (minutes)	Total consumable cost (£)	Total time cost (£)	Total cost (£)
Intravenous medications[a]	16	0.61	3.22	3.83
Intramuscular medications[b]	6	0.37	1.21	1.58
Rectal medications[c]	6	0.12	1.21	1.33
Administering blood[d]	13	2.61	2.61	5.22

[a] Includes syringe, sterile water (10ml), needle, swab, sterile gloves & apron.
[b] Includes syringe, sterile water (10ml), needle, swab, gloves & apron.
[c] Includes lubricating gel, sterile gloves & apron.
[d] Includes giving set, intravenous dressing, swab, sterile gloves & apron.