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Identifying the Value of Computers in Dialysis

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Key Words

Dialysis • Automation • Computers • Electronic medical records • Clinical information • Financial systems • Economic benefit • Information optimization

Abstract

Dialysis providers use computers to automate complicated tasks, ease staff burden, and develop knowledge or understanding to improve operations and patient care. Some applications are successful, others are not. Success can be economically quantified. Business — billing and accounts receivable computerization — can yield over USD 5.00 for USD 1.00 invested. The clinical case is more complex and difficult to economically justify. Computerization of clinical information for charge capture is the simplest application (<USD 1.00/treatment) yielding the greatest benefit. Economic benefits for improving quality of care through electronic medical records are more problematic. Provider benefit of clinical computing is strictly the net income from more dialysis treatments. Greater complexity — e.g., total electronic records — means more expensive systems and increased staff effort. Many systems cost in the USD 5.00 + range which must be paid by increasing provider overhead. Dialysis providers must determine the point where computerization no longer decreases operational costs as computing cost increases. This is a classical optimization problem; its solution is crucial to the economic health of the dialysis enterprise.

Introduction

Over the past few decades, computers have been increasingly used in most areas of business and their application to various dialysis activities — ‘renal management systems’ — is no exception. It should be noted, however, that in whatever context computers are used, they are merely tools that can help with complex tasks [1].

Renal management systems fall into two broad categories — business systems and clinical systems. The dialysis industry has used computers effectively in many aspects of the nonclinical part of its business. The use of computerized clinical systems, however, has lagged. Over the past decade there have been mixed reviews regarding whether this technology has had an impact on the conduct of the treatment itself. There has in fact been a general acceptance of other technological improvements in dialysis (for example, with microprocessor-driven dialysis machines), but dialysis providers have not universally adopted the use of computers in guiding the delivery of clinical care [1].

Typical goals of introducing computerization into virtually any field are: (1) to automate complicated, repetitive tasks and ease staff burden and (2) to develop knowledge and understanding of an operation so that it can be conducted in a more effective manner.

Defining the Problem to Develop the Solution

It may seem obvious that a problem should be defined before a solution is attempted. However, the rapid expansion of computer capabilities has also fed the view that if one collects large amounts of data, the answers to problems, some that have not even been asked, will appear. Some in the computer and business fields have recognized that much data collection and computerization are apparently done for their own sake — it is after all very easy with modem technology [2–4]. However, the problem is that a vast increase in data without a guiding reason behind their collection, results in no greater understanding (knowledge). Walter Wristen [4] has pointed out the paradox of the use of information technology: 'The incessant production of new data and their instantaneous communication create a paradox: Information, the thing that eliminates uncertainty, now increases everybody's feeling of insecurity because of the failure to convert data into knowledge.'

With the small operating margins in dialysis and the potential increased operating cost that computerization represents, it is critical to make sure that systems are addressing a defined and important problem. The keys to getting benefit out of renal management systems are: (1) to clearly define what understanding (or knowledge) is desired; (2) to determine what information is needed to gain that understanding, and (3) to select the data that need to be collected to generate that information.

This process — moving from the definition of the knowledge desired to the data to be collected — vastly reduces the amount of effort and data that need to be collected and processed. It can also control the cost of the resulting technological solution .

Evaluating the Cost and Benefits of Computer Systems in Dialysis

Cost of Operating Computerized Systems

While elements of computer costs will be discussed below, it should be stressed that costs are not trivial and are not solely the cost of hardware and software. Computerization involves the entire organization — staff need to be trained, staff specifically skilled in the software need to be hired, operating routines may need to be changed. In addition, once an application is relied on to perform a function, any disruption can be chaotic; thus contingency plans must be made for such a possibility. It follows that the value of automation should be great enough to warrant these costs.

Computerizing Easily Defined — Tedious Tasks versus Analytical Applications

Of the two categories of computerization described above, automation of complicated, repetitive tasks is the most obvious application and the one that is the easiest to define. Examples of computerized functions in this category are payroll, general ledger, and accounting systems and most renal business systems. In contrast, defining how to develop knowledge to better understand an operation, such as improving clinical care, involves analysis of several functions and is a much more difficult task.

Establishing the Overall Goals for Computerization

In setting goals for computerization one must take care to concentrate on the problem of interest, not the mechanism — the means of collecting and storing data. Examples of a 'problem of interest' are: how to reduce receivables in the business setting or how to track and evaluate blood access problems in a dialysis clinic. With the unsophisticated potential user, data collection and storage can assume the stature of a goal and may be lumped together as the need for a 'paperless' enterprise. This approach probably results from the use of manual methods that in many cases lend themselves to automation. However, it is often not paper itself that is the problem but rather the inability to retrieve specific pieces of information without sifting through large amounts of recorded data. Paper is attacked not because it is paper but because the information it contains is a mixture of the useful and the trivial. Putting all of those same data in a database can help, but it merely moves the same mixture of useful and trivial data to an electronic storage medium.

The real goals of computerization should concentrate on desired results. Goals should include: (1) automating complicated tasks — billing, accounts payable, payroll; (2) assuring complete charge capture of treatment items; (3) easing staff burden by (i) eliminating data copying, (ii) producing analyses for controlling agencies and (iii) making information useful; (4) making better use of clinical information, and (5) anticipating problems and assure critical problems are being addressed.

Determining the Value of Computerization

To determine the value of computerization, one has to quantify the value of the specific goals. Some valuations are easier than others, such as the value of decreasing accounts receivable [5]. For example. for a 250-patient enterprise (36,000 treatments per year; USD 8.1 million annual revenue; USD 22,500 per day) a typical provider could have 75 days of revenue (USD 1,687,500) not yet paid (days service outstanding, DSO). Increasing the speed of collections and reducing that number by USD 450,000 to 1,237,500 (55 days DSO) would yield USD 450,000 at an annual debt service of USD 45,000 (USD 1.25 per treatment). Other tasks, such as being able to ease staff burden or anticipate problems, are more difficult to quantify.

Nonetheless, to be able to evaluate the extent to which computerization is justifiable, some estimate of the value of each of the candidate goals should be made.

How Does the Dialysis Facility Pay for Computerization?

The dialysis provider has been in a tight financial situation for many years. Even with the recent increase in the composite rate, operating margins are small. As a result the dialysis provider does not have the luxury of avoiding the question, ‘How are we going to pay for computerization’? The answer is relatively simple. There are three options:

(1) *Increase revenue by computerization:* Increased revenue with effective means to capture charges, to reduce abandoned charges (the ones that are viewed ‘not worth pursuing’ when denied), or increasing the number of treatments delivered and billed for.

(2) *Decrease in costs by computerization:* Costs can be decreased through more effective administrative and/or clinical staff (i.e., reducing the personnel per unit of service), reducing operating costs (such as lower debt service due to reduced level of receivables, as described above), or some other efficiency that has a financial impact.

(3) *Increase the cost of doing business:* This option says, ‘We need computerization. It won’t increase revenue or decrease cost, or if it does, it won’t pay for itself however, we need it so it will be a part of our overhead costs’.

Defining the Value, Cost and Benefit Expected from Automation

Figure 1 illustrates the approach to this value analysis and shows that there are costs associated with two aspects of the problem of automation for most processes: (1) the system cost (curve A in fig. 1) and (2) the cost of the function or operation that is the goal for computerization (curve B in fig. 1).

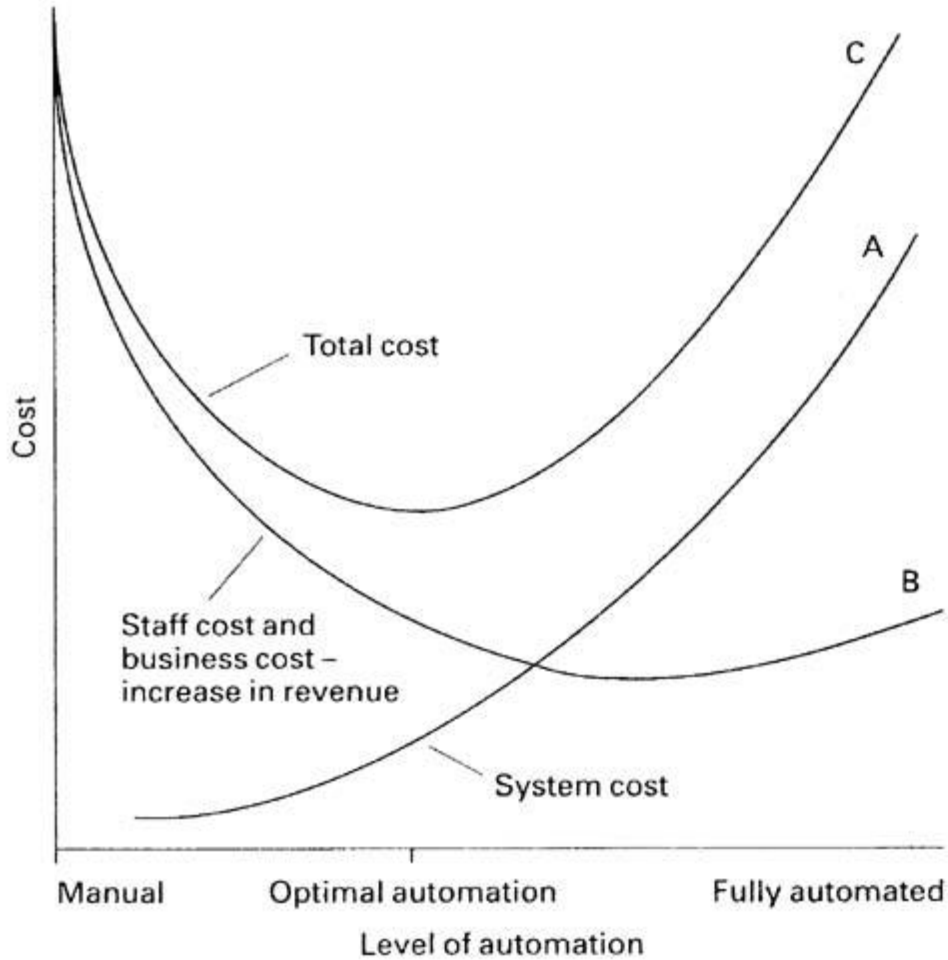

Fig. 1. Selecting the level of automation is an optimization problem. As the level of automation increases, the system cost (A) increases, which at first is outweighed by the decrease in staff cost and business cost (B) resulting in an increase in revenue. At a certain point, the total cost of staff and system (C) will increase, as the system becomes more complex. This can lead to a higher operating cost and a loss of revenue.

The cost of the system is a combination of the actual purchase and ongoing costs of the system, plus the cost of using the system. System costs include support costs and internal staff costs that are outside of vendor expenses; these costs will increase with the complexity of the system as the general system user routinely accesses less of the overall system and more specialized knowledge is needed [6]. It would be assumed that as the system becomes more complex it does so because it has features that make it more useful and better able to meet the goals that have been outlined for its use. It should be noted that if the increased complexity is the result of collecting and storing all data whether or not it is useful or trivial, this added cost may have little or no benefit.

The cost of the function as it is computerized is shown in figure 1 as curve B. As the system used to address the function becomes more complex, the costs of the functions it addresses should decrease. This is shown as an initial rapid decrease with modest computer complexity (and expenditure) because there are elements of the problem that readily lend themselves to automation. This cost relationship is shown to level off as the system complexity increases to the point where it no longer has much impact. Although there may continue to be a decrease in the cost of the target function, increases in staff costs to operate the system ultimately dominate.

The total cost to the provider is the sum of these two curves, the system cost (A) and the cost of the function (B) (shown as curve C). This cost is seen to reach a minimum. which will be the ideal operating point for the provider and represents the point where the added savings in the cost of the functions are offset by the increases in system cost. This figure illustrates that computerization without limit does not provide the same benefits as automation to an optimum level. Once again, finding this optimum requires definition of the problems to be solved and selecting a solution that meets those needs.

System acquisition and operating cost	Limited Functionality (system A)	Optimized functionality (system B)
Small operation	0.50–1.00	1.00–1.50
Larger, multi-facility operation	0.30–0.70	0.60–1.00
Typical cost	0.70	1.00
Relative cost savings [7]	–	4.94
Net cost benefit	-0.70	3.94
Net cost B vs. A		4.64

Table 1. Normalized system cost (in USD) of systems compared in reference 7 (costs per treatment)

Illustration of Analysis and Evaluation of a Dialysis Business Function — Billing and AR Tracking

Virtually no dialysis provider produces claims and tracks receivables by hand. There are many automated systems in use in the field. Some are 'home grown,' some are ones that hospitals traditionally use for their acutely admitted patients, some are modifications of systems for another aspect of medicine, and some are designed specifically for dialysis. An analysis of these systems has been presented elsewhere [see 7]. A summary of these results is shown in Table 1 and compares two widely used dialysis billing systems. From this table, the actual costs of both of these systems are less than USD 1.00 per treatment. The purchase price of system A is about 30% lower than that for system B. The combined analysis, however (as indicated in figure 1 as the sum of the costs), shows that even though system A is 'cheaper', the overall cost of system A is actually higher by USD 4.64 per treatment because it lacks the specific capabilities that resulted in the USD 4.94 per treatment savings when using system B. The reader is referred to Sargent [7] for the detailed analysis.

Evaluating the Value and Benefit of Clinical Information for the Dialysis Provider

Defining and analyzing the automation of clinical information is a much more difficult task than for automating business systems. It is a more difficult task to clearly define the goals for computerizing clinical data. The cost of computer complexity will be similar to business systems. However, the cost of the clinical problem and how it is affected by computerization is difficult to determine and may be composed of several factors.

Likely Benefits of Computerization of Clinical Information

As was stated above, it is important to understand the goals of computerization before investing in hardware, software and personnel. Those goals should include being able to automate complicated, repetitive tasks and easing staff burden, and developing knowledge and understanding of an operation so that it can be conducted in a more effective manner.

These goals can apply when looking at business or clinical systems, although the tasks in a business system are more complicated than in a clinical system. However:

1. It is likely that charge capture can be improved by computerization of a small subset of clinical data.
2. It may be possible to ease staff burden with a system because of the high visibility of data retrieval tasks associated with regulatory agencies, the information needs for patient admission and travel, and the convenience associated with being able to access outcome and status data remotely (e.g., an off-hour hospital admission of a patient requiring physician involvement).
3. The potential would also seem to exist to use information better in order to anticipate problems — either by implementing CQI programs or assuring that critical information is passed on to subsequent care givers.

Experience with existing computerization gives some insight regarding the extent that these benefits can actually be realized. Addressing complicated tasks and easing staff burden would be expected to reduce labor costs. By and large this has not been the experience of the dialysis field. As dialysis practitioners know, the field has done an heroic job over the past decade and more to control staff costs. To suggest that staff can be further reduced by the introduction of computers would strike some as unlikely.

Charge capture is an area where there can be real benefit, depending on the level of missed charges that currently exist. The value of this capability will depend on the systems and processes the provider currently has in place to assure that charges are not missed. Once again, during the past decade as margins became ever tighter, surviving dialysis providers have developed methods to address this problem.

The benefit to be derived from better use of information through CQI programs and anticipation of problems falls into the category of improvement of quality of patient care. The quantifiable result of this use of information for the provider — the purchaser of the system — is in fewer hospitalizations and lower mortality. For example, the average patient in the U.S. misses approximately 5% of expected treatments per year due to hospitalization (7—8 treatments) [8. 9]. If through better use of information this number can be reduced to half, there will be four extra treatments performed by the dialysis facility (see below for analysis of the value of these added treatments). In addition, with a 'computerized' dialysis facility it is possible that there will be an increase in referrals because physicians may find it easier to follow patients with automation of records.

From the financial point of view of the provider, who must purchase the system. the single benefit of automation that achieves the goal of better patient care is that more treatments will be conducted. The value of any such additional treatments will be the margin associated with a dialysis treatment — the excess of increased revenue over the cost of the treatment.

Financial Impact of Increasing Treatments due to Better Information

The cost benefit for increased numbers of treatments is a calculable value, which depends on the revenue per treatment and the corresponding margin for the particular facility. It is true that the margin for incremental treatments (i.e., a small number of treatments that will not increase staff cost or other 'semi-fixed' costs) may be high. However, for greater increases the semi-fixed costs must also rise and the margins decrease.

The financial benefit of increasing treatments by better use of information can be easily quantified. For a facility with R revenue per treatment (USD/Tx), with a margin of m (expressed as a decimal fraction), and clinical system cost of C (USD/Tx), total annual system costs will be $\Sigma Tx \cdot C$ (where ΣTx are the total number of treatments per year). The increase in available revenue (the difference in increased revenue and increased expenses associated with increased treatments) will be $\Delta Tx \cdot R \cdot m$ (where ΔTx is the increase in number of treatments annually). To break even with computer costs, the computer cost must equal the increased available revenue:

$$\Sigma Tx \bullet C = \Delta Tx \bullet R \bullet m \qquad (1a)$$

$$\Delta Tx / \Sigma Tx = C / (R \bullet m) \qquad (1b)$$

In equation 1b, $\Delta Tx/\Sigma Tx$ is the fractional increase in treatments needed for the facility to pay for its computer capability that addresses the quality of care issue.

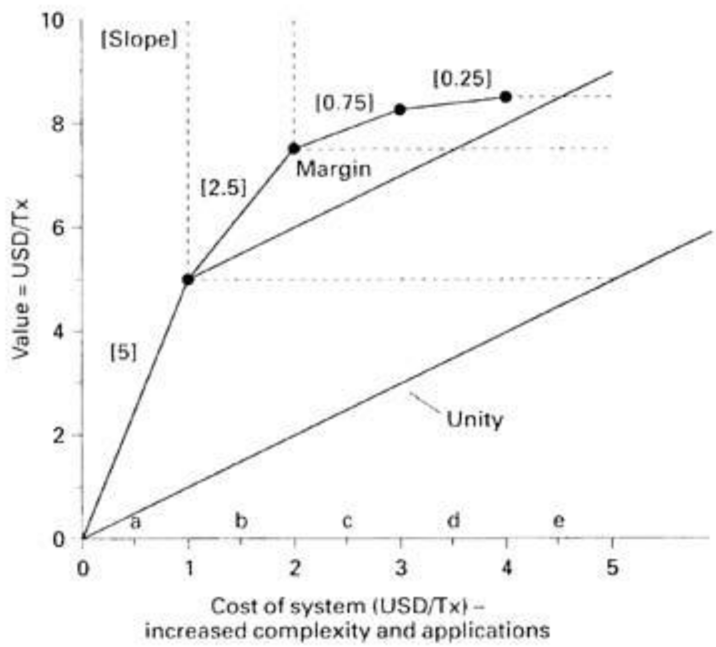

Fig. 2. The value derived from automation as a function is shown. Depending on the system implemented, margins may be small or non-existent. The types of systems that can be implemented are: a = billing receivable: b = charge capture: c = basic clinical parameter; d = total electronic medical record; e = totally paperless.

A graphical representation of equation lb is shown in figure 2. with several different levels of revenue per treatment (R) and margin (in). The annual cost of a midrange computer system for a I 50-patient facility (21,600 treatments annually) is USD 65,505 [see 5, 7]. If this cost is spread over the 21,600 treatments, it amounts to USD 3.03 per treatment for computerization.

In figure 4 for a system that costs USD 3.00 per treatment, a facility with USD 225 per treatment in revenue and 15% margins will need to increase treatments by 9% to pay for the system. For a 150-patient facility (21,600 treatments — annual computer cost of USD 64,800) this will mean 1.944 additional treatments or an increase of more than 6 treatments per treatment day. Singling out the value of halving hospitalizations discussed above and an increase in treatments of 2.5%, to prevent operating at a loss, the cost of computerization would have to be less than USD 0.84 per treatment.

It is unclear if this increase in treatment numbers derived above is likely to result from better use of clinical information. What is clear, even if such increases are possible, is that it is important to implement only those aspects of patient information most likely to help achieve this increase in quality of care so that the financial benefit can more easily meet the increased system cost. That is, the increase in treatments to break even will be half as much for a system that costs USD 1.50 per treatment as for a system that costs USD 3.00. In addition, because it is possible that the needed increases in treatments will not occur, controlling the cost of automation will result in a lower level of expense that has to be incorporated in the 'cost of doing business' or provider overhead.

In addition to increased numbers of treatments, there are other measurable cost savings in the renal setting that can be attributable to computerization. A better understanding of treatment might permit more effective use of a medication and, depending on the margins for such a medication, this could either increase or decrease a facility's margin. That is, if a provider administers a medication at a loss, optimization of its use would improve the treatment margin. By and large, medications that fall into this category — those provided at a loss to the dialysis enterprise — have always drawn the provider's attention, such as the early use of Epogen®, reimbursed initially at a fixed amount per treatment. When larger doses needed to be administered, the provider administered the drug subcutaneously, in order to minimize the amounts used and control the unreimbursed expenditures.

Composite Value and Cost of Automation

Taken together, the value derived from automation as a function of the cost is shown in figure 2. At first glance, this figure would seem to indicate that there is considerable benefit to be derived from computerization because the curve is above the break-even line throughout most of the figure. It is important to realize, however, that the various segments of the curve shown in this figure are from the automation of specific functions. As was evaluated in reference 7, the payoff for moving to an effective billing and receivables system had a value of USD 5.00 for USD 1.00 expended (resulting in a line of slope 5.0 in this portion of the figure). We have estimated from our 'abandoned charge' analysis that the charge capture portion of a clinical system will add approximately USD 2.50 for an additional USD 1.00 in computerization (the cost of added automation needed to supply this capability). We have further estimated that increased computerization cannot be totally paid for by adding treatments and that there will be a value of USD 0.75 for an additional USD 1.00 of computer cost (it remains to be determined if even this level of treatment increase can be realized). A feature of figure 2 is that with aggressive computerization (moving to the right), the value no longer increases and in fact could decrease as the computer system requires more and more staff effort. Overall, figure 2, while showing that considerable computerization can be installed and have overall value, it is the billing and receivables and charge capture capabilities that make the major contribution to a profit in the overall process of automation.

Incremental Value and Cost of Automation

The coordinates shown in the middle of figure 2 indicate what the analysis would show for those who have already implemented the billing/AR component of this figure and who are evaluating automation of their clinical records (the system that will provide charge capture and other clinical information). This analysis should generate some caution on the part of the provider planning to automate its clinical records because one is relying heavily on the charge capture aspects of the system to make it affordable.

The Hierarchy of Clinical Data

One flawed assumption of the ‘paperless’ approach that is all data are of equal importance and need to be collected. A provider may also feel that because data are in electronic form, they should be included in the database (e.g., run parameters from the dialysis machine). In reality, data can be separated into several categories:

1. Data that are needed to determine current status and progress of the treatment: (i) These include blood and dialysate flow, temperatures, intradialytic blood pressures, initial safety tests on the dialyzer and machine parameters. (i) These are used to monitor intradialytic events and are seldom needed after the treatment is complete.
2. *Data that indicate presenting and long-term status of the patient:* (i) These include patient assessment pre/ post treatment, pre/post blood pressure, lowest blood pressure during a treatment, pre/post weight, dry (or target) weight, weight change. (ii) These are used to track patient status and treatment problems. (iii) They can be useful for longitudinal tracking of the patient.
3. *Data that track treatment delivery and treatment charges:* (i) These include dialyzer used, average blood flow, KT/V, medications administered. (ii) These are billable events and are parameters that affect outcome. (iii) They are used to better understand reasons for different outcomes and to generate charges.

4. *Outcome data:* (i) These include laboratory values, key markers of medical progress. (ii) These are used to evaluate whether treatment and/or treatment changes are effective. (iii) They help track overall medical status and provide triggers for modifying treatment.
5. *Other data:* (i) These include access-related events and problems, general medical problems. (ii) These are used to assess and react to the patient's general medical condition. (iii) They help determine areas where medical effort should be concentrated.
6. *Administrative information:* (i) These include HCFA 2728 form and other justification for treatment, power of attorney (advanced directives), acknowledgment of being informed of treatment options, other legal documents. (ii) They are needed for legal and regulatory requirements. (iii) They are used as legal backup.

All of the above data can be computerized and stored thereby eliminating much of paper and record-keeping associated with the current medical record. Of the above list the first item, data needed to monitor the status of treatment, represents a considerable volume of data. Each treatment will have a large number of treatment parameters that are used to monitor the status of the machine and conduct of the treatment. Over the past decade with increasingly sophisticated equipment, more and more of these data can be electronically transmitted to databases. These data, however, are of minor value once a dialysis treatment is compete, although they could account for a large percentage of data in an electronic medical record. In addition, the manual recording of these data assumes that patient care staff have had periodic encounters with the patient.

The remaining items (with the exception of administrative information) describe data that can be used to track patient progress, to assure that problems are analyzed for causes, and to assure that problems are passed on to other clinical personnel. These will characteristically represent a much smaller data set than the machine and intradialytic parameters. As a result there may be only a modest effort associated with gathering them and entering them into the database. They are also parameters that treatment personnel realize are of long-term value and can help them in delivering quality care and anticipating clinical problems. As such, caregivers may better understand the value of collecting accurate information and computerizing it so that they can take advantage of this information in the future.

The last item, administrative information, is of limited value to the caregiver when addressing quality of care issues. It is important to know that an advanced directive exists and what resuscitation is desired, but the actual documentation does not need to be in a database.

Complexity Associated with the Electronic Medical Record

If a computer system strives to be the total patient chart or electronic medical record, there will be considerable ‘overhead’ associated with the system. It is necessary to have extensive security, electronic signatures, and methods whereby only certain staff members can access specific parts of the database. All of these restrictions have to be administered. Because of the legal nature of such a record, countersigning of predialysis machine checks, for example, need to be mandated and these data retained as records.

Thus, computerizing all patient medical records rather than tracking key clinical indicators can be labor-intensive, frustrating the goal of ‘easing staff burden’.

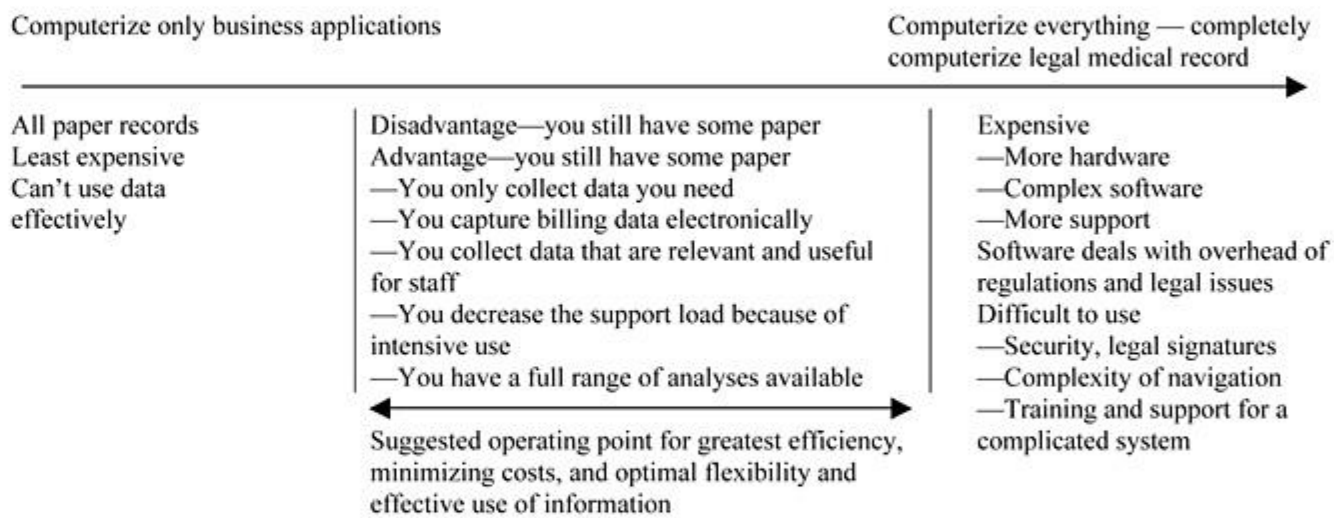

Fig. 3. It is critical for a dialysis provider to clearly understand the costs and benefits of a computer system and it is up to the provider to decide what capabilities are appropriate for its specific needs. Left side of continuum = the paper record with computerization of only business functions. Right side of continuum = the complete electronic medical record. Center of continuum = the suggested operating point. The hybrid system retains paper records and computerizes critical aspects of clinical care.

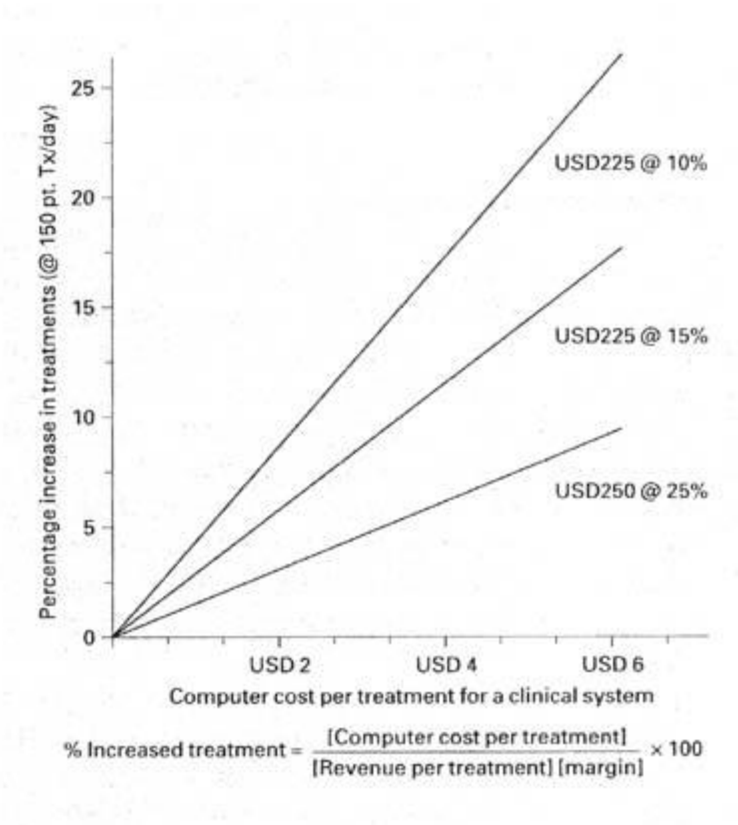

Fig. 4. A substantial increase in treatments is needed to pay for clinical capabilities. For example, for a system that costs USD 3 per treatment, a facility with U SD 225 per treatment in revenue and 15% margins will need to increase treatments by 9% to pay for the system .

Finding the Right System

Computers fit where you want them to fit. There is a wide range of capabilities that are available and it is up to the dialysis provider to decide what capabilities are appropriate for its specific needs (see fig. 3). It is critical that the benefits and costs are clearly understood. As has been discussed, greater complexity may provide not only more capabilities but also greater cost — both in purchase price and in maintenance, support, and internal infrastructure. In addition, a complex system also can place an increased data entry burden on treatment staff. Figure 4 shows the options:

(1) *The complete electronic medical record (right side of the continuum):* It is the most expensive choice (see the cost of ownership — fig. 1). With the right system, clinical direction and an enthusiastic staff, such systems can be a major factor in increased quality care and can be locally justified even if their cost has to be added to the cost of doing business.

(2) *The paper record with computerization of only business functions (left side of the continuum):* It is virtually impossible to conduct business, particularly in the dialysis, with manual accounting and billing systems. The choice of paper records of clinical information for such a provider is less expensive but makes the effective use of them difficult because all analyses need to be conducted by hand. The provider also has to rely on the compulsiveness of clinical and reimbursement staff to assure that all billable events are captured. Evaluation of quality issues are difficult although individual analyses are possible using common office spreadsheet software and other automated tools.

(3) *The hybrid system — retain paper records and computerize critical aspects of clinical care:* The disadvantage of this approach is that the facility still needs to maintain some paper medical records. The advantages are that with a paper record, the collection of relatively unimportant data (e.g.. flow rates, temperature, machine checks, etc.) do not need to be stored in the system with the attendant legal requirements. In addition, all of the complexity and extra staff work required to support a legal record are not needed. Only needed data are collected which avoids extra staff work, and data that are collected and entered are of use to the staff who collect them. Such a system can be used to capture billing data — the single most valuable aspect of computerized clinical systems (see fig. 2), and a full range of analyses can be available of the critical parameters that are entered into the system.

Conclusion

Computers are tools that when used properly can provide considerable benefit to the user and can, in the dialysis setting, effectively increase the business success of a provider and help staff understand the critical aspects of quality patient care. Computers are expensive and the more complex they are, the more they cost. The costs associated with computerization are not just the purchase price of the system but include staff involvement and extra effort by key personnel. Costs of computers can range from USD 1.00 per treatment to well over USD 6.00 [see 6]. In choosing the level of computerization desired, one should evaluate the expected costs as well as how those costs will be borne (decrease in other costs, an increase in revenue, or an increase in facility overhead). Although computers have made uneven inroads in the dialysis field — being used mainly in the business tasks of the provider — they will become more and more a part of clinical care of the ESRD patient as specific problems are defined. With such definition the computer can truly fulfill its role in supplying information to increase knowledge of a patient’s medical problems which in turn will ultimately result in higher quality care.

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