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Computerised triage in a prostate assessment clinic

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An MS Office package has been developed to score IPSS, take a patient history, compare flows with nomograms and decide on interim management. This is based on these scores, residual volume and laboratory results. A clearly formatted GP letter is produced. The patient uses a touch screen to answer questions on the IPSS and other medical history. These questions and responses are stored in Excel spread sheets. Clinic staff then enter results of flow studies, urinalysis, U&E and PSA. Excel Visual Basic creates a detailed printout for the notes and the MS Office mail merge facility creates a summary printout, which also serves as a letter to the GP. Excel allows embedding of formulae and program code to implement the rules for management. Based on these rules, the program either generates a request for an urgent appointment in the clinic or recommends the use of either an alpha blocker (if not contraindicated by medical history) or 5 alpha reductase inhibitors in the interim period before they are reviewed in clinic. A total of 139 patients have been seen and the computer decisions compared with those of a consultant urologist. Agreement was found in 106, disagreement in 33. However, 21 of the 33 involved computer oversensitivity to flow results. We do not anticipate difficulty improving this and are investigating using an artificial neural network. Of the other 12 patients, the urologist departed from the fixed rules for IPSS, creatinine, PSA and residual urine when only one variable was slightly abnormal. To conclude, this novel user-friendly system shows great potential in the management of prostate outpatients. Some tuning is needed, with particular respect to uroflow results.
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Introduction

Approximately 2.5 million men currently suffer from symptoms of benign prostatic hypertrophy in the UK and the number is expected to grow by almost 50% by the year 2025.[1] Although not every man with symptomatic BPH is bothered by his lower urinary tract symptoms (LUTS), many men will seek advice either for reassurance or to explore medical treatment options. It is likely, therefore, that urologists will have to cope with an increasing number of elderly males seeking medical advice for LUTS. Nurse-led prostate clinics have proved to be a highly effective method of assessing patients with LUTS and many urology units now run such clinics.[2]

To improve efficiency and utilisation of staffing in our nurse-led prostate assessment clinic, we developed an MS Office-based program, wherein details of patient's history, IPSS and results of investigations are fed into the computer, which then generates a printout of these reports along with a decision on the urgency of the case to be reviewed in clinic. The decisions made by the program were compared with those of a consultant urologist.

Materials and methods

Patients

A total of 139 consecutive patients were recruited from the urology prostate clinic. All were GP referrals. If they were already on medication for LUTS, it was not discontinued.

The computer program

In developing a program of this nature, several points had to be borne in mind. It has to be easy to use, both by

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the patient and by the nursing staff. A touch screen interface was considered to be ideal. We have more than 10 y of experience in patient history taking by PC in urology and anaesthetic preassessment. Previous work has shown that such systems achieve good compliance and accuracy with patients and, in general, take less time than nurse-completed questionnaires.[3–5] The patient should be presented with clear large print screens. Symptoms would be best recorded in a validated format such as the IPSS. The printout would have to be well set out containing a summary of the patient's visit to the prostate assessment clinic. In addition, educational help screens for patients would be useful.

The MS Office package fitted all these criteria. The patient screens are presented via PowerPoint (Figure 1), the questions and the patients' answers are stored in Excel and using the mail merge facility, the summary printout is presented via Word and thus formatted exactly as required. Furthermore, the visual basic programming language that is integral to MS Office was found to be adequate for all the analysis.

Data input

The patient uses a touch screen to answer multiple choice questions on the IPSS and on general medical history. He can review his responses before saving them for the printout. Nursing staff enter details of relevant drug and medical history in free text, along with results of investigations performed in the clinic. These investigations include urinalysis with an MSSU if urinalysis is positive, full blood count, serum creatinine, urea and electrolytes, PSA, urine flow studies and measurement of residual urine volumes. When possible, two flow studies are performed and the better result is analysed. The patient's responses and results of investigations are stored in Excel spread sheets.

Data analysis and decision-making

When all fields in the input are complete, the computer generates a printout along with a decision on interim management in these patients. This includes a request for a routine appointment in the urology clinic and advises the use of either an alpha blocker (if not contraindicated by the medical history) or 5 alpha reductase inhibitor in the interim period. However, an urgent appointment is requested if the patient has any one of the following:

- Severe IPSS (>18)
- Urine dipstick positive for blood
- Raised serum creatinine (>120 μmol/l)
- Raised PSA (age-related limit)
- Residual urine volume >350 ml.
- Poor Q_{max} as judged by nomogram.

When urinalysis is positive for blood, a sample of urine is sent for culture and sensitivity and the report entered into the computer.

The upper limit for serum creatinine levels is based on our hospital laboratory reference value.

For the analysis of PSA values, we had separate age-related reference values for Caucasian, Asian and Afro–Caribbean racial groups. However, for simplicity of use, we combined the graphs to have an average age-related reference value.

Initially, a residual urine of 200 ml or greater was set to trigger an urgent appointment. However, this value appeared to be too low and a number of patients were given an urgent appointment based only on their residual volumes. As there was no consensus in the literature about residual volumes indicating bladder outflow obstruction, we set a higher level of 350 ml. When results of the flow studies are entered, the program plots the values on four published nomograms for flow studies — Rollema (Q_{max} and T_{void}),[6] Susset[7] and Haylen.[8] Three of these are Q_{max} nomograms and one is for voiding time. The nomograms are used to score the flow between 0 (unobstructed) and 2 (obstructed). In our rule-based program a score of 8 (obstructed on all nomograms) classifies the flow as 'poor' and triggers an urgent appointment.

All the criteria for urgent referral were selected to be sensitive for possible cancer or renal failure. Quality of life, although measured, was not an indicator for urgent referral.

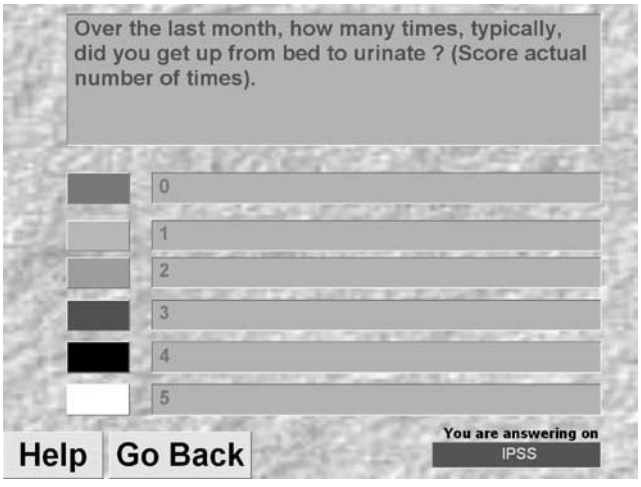
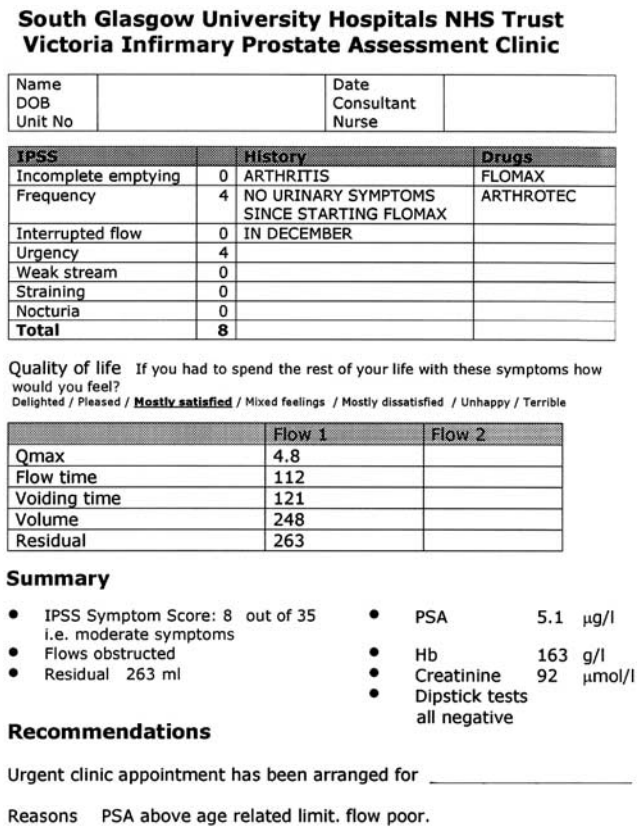


Figure 1 *Sample of Powerpoint Patient Screen.*

Printout

There are two types of printout: an exhaustive one with all symptoms and data and also a summary. The patient checks the former and it is filed in the case sheet. The summary printout is a word document that is generated from the Excel spread sheet using the mail merge process. The top part of the document has patient details, date of visit to the clinic and details of the nursing staff and consultant involved (Figure 2).

The next section shows details of the IPSS and the scores entered. There is a column for medical history and current medication. The section on quality of life has the various responses printed with the selected option programmed to appear in bold lettering. The next section shows the results of the flow studies and results of other investigation performed in the clinic. The last section has the decision and recommendations on interim management, and it has also been programmed to print reasons why a particular decision had been taken by the computer.



South Glasgow University Hospitals NHS Trust
Victoria Infirmary Prostate Assessment Clinic

Name		Date	
DOB		Consultant	
Unit No		Nurse	

IPSS		History	Drugs
Incomplete emptying	0	ARTHRITIS	FLOMAX
Frequency	4	NO URINARY SYMPTOMS SINCE STARTING FLOMAX	ARTHROTEC
Interrupted flow	0	IN DECEMBER	
Urgency	4		
Weak stream	0		
Straining	0		
Nocturia	0		
Total	**8**		

Quality of life If you had to spend the rest of your life with these symptoms how would you feel?
Delighted / Pleased / **Mostly satisfied** / Mixed feelings / Mostly dissatisfied / Unhappy / Terrible

	Flow 1	Flow 2
Qmax	4.8	
Flow time	112	
Voiding time	121	
Volume	248	
Residual	263	

Summary

- IPSS Symptom Score: 8 out of 35 i.e. moderate symptoms
- Flows obstructed
- Residual 263 ml
- PSA 5.1 µg/l
- Hb 163 g/l
- Creatinine 92 µmol/l
- Dipstick tests all negative

Recommendations

Urgent clinic appointment has been arranged for _____

Reasons PSA above age related limit. flow poor.

Figure 2 *Sample of final print out.*

Hardware requirements

The program will run on any personal computer running Windows 95 and Office 97 or later versions. Visual basic add-ins (which come as standard) needed to be implemented. The system uses a 17-in touch-sensitive screen monitor, which essentially emulates a mouse. After first use, some extra software had to be written to eliminate the phenomenon of 'double hit' when a patient either holds pressure for too long or accidentally strikes the target twice. Without this software, the second hit would become the answer to the next question.

The software runs at two different sites within the trust and the PCs are linked via NOVELL, so changes or troubleshooting can be performed remotely.

Study design

This was a prospective study carried out in our nurse-led prostate assessment clinic. We compared the decisions generated by the program with those of a blinded consultant urologist. In cases where it was felt that the computer's decision was inappropriate, it was overruled by the consultant's decision. The reasons for disagreement in the decisions were noted and analysed.

Results

The program was tested in one of the two sites where we conduct a prostate assessment clinic in our trust. It has been found to be user friendly with both the nursing staff and the patients finding it easy to use. In addition, nursing staff have benefited from the extra time released by patients using the touch screen themselves, to organise other activities in the prostate clinics such as urinalysis, blood tests and flow studies. On average, it takes around 25 min for a patient to complete the computer history part of the visit to the Prostate Assessment Clinic. Since the program was implemented, the number of patients seen in the clinic has increased from eight patients per session to 12 patients per session.

When we compared the computer's decision with that of a consultant urologist, out of 139 patients there was agreement in 106 and disagreement in 33 patients. In all the 33 decisions that disagreed, the computer had requested an urgent appointment when a routine appointment would have been appropriate. The disagreements are summarised in Table 1.

In 21 of these 33, it was entirely due to the program's assessment of a poor flow rate. In the remaining 12 cases, the urologist departed from the agreed rules for IPSS in four patients, for residual urine in two patients, creatinine level in three patients and for PSA level in one patient. One patient had a combination of a raised creatinine and poor flow rate and two other patients had a combination of a high IPSS and poor flow rate.

Of the 106 patients in whom there was agreement between the consultant urologist and the computer program, 37 patients had a routine appointment and the remaining 69 had an urgent appointment (Table 2). A total of 12 patients had further investigations with TRUS biopsies. Four of these patients had a diagnosis of a prostatic tumour.

Discussion

Computers have become a valuable and popular tool in various fields of medicine. In addition, they are indispensable for activities such as accessing medical literature, electronic pharmacopoeias, patient tracking, medical education, research, business management, e-prescribing and patient confidentiality. There are also speciality-specific applications for personal digital assistants.[9]

Computer applications have been used to set up database registries[10] and in the general function of various clinics such as hand injury clinics, dermatology and orthopaedics.[11] In urology, computers have been used for automated classification in uroflowmetry and simultaneous pressure-flow studies.

Table 1 Summary of disagreement between urologist and computer (actual values of test parameter in brackets)

Total	Computer decision urgent because	Urologist decision
21	Poor flow	Nonurgent
4	High IPSS (19, 23, 22, 20)	Nonurgent
1	High residual (388 ml)	Nonurgent
3	High creatinine (132, 124, 125 (mmol/l)	Nonurgent
1	High PSA (0.2 above limit (μmol/l)	Nonurgent
1	High creatinine (127) & poor Q_{max} (10 ml/s)	Nonurgent
2	High IPSS (21, 19) & poor Q_{max} (12, 6)	Nonurgent

Table 2 Summary of agreement between urologist and computer

Reason for urgent referral	Number of patients
High residual volume, high IPSS, poor flow	2
High residual volume, high IPSS, raised creatinine	1
Raised PSA	7
Raised PSA, raised creatinine	2
Raised PSA, dipstick positive for blood	2
Raised PSA, poor flow	9
Raised PSA, high IPSS	2
Raised PSA, high IPSS, poor flow	5
Raised PSA, high residual volume	1
High IPSS	3
High IPSS, poor flow	6
High IPSS, poor flow, dipstick positive for blood	1
High IPSS, dipstick positive for blood	3
Poor flow	1
Poor flow, dipstick positive for blood	3
Dipstick positive for blood	13
Raised creatinine	3
Raised creatinine, dipstick positive for blood	2
Raised creatinine, poor flow	3

However, this program was novel in that it assisted in the triage of patients attending the prostate assessment clinic. The program itself was easy to use for both nursing staff and patients. In addition, the program speeded up the process of informing GPs about the patients' results. Patients with a normal profile were less anxious about their symptoms and it was possible to initiate treatment earlier in symptomatic patients. A 'quick and early' diagnostic route provides a higher quality service through improved effectiveness and cost-effectiveness compared with conventional outpatients and such a program seems essential in improving patient care especially in the situation where urology teams have to work across sites, which can lead to delays in vetting results.

In all the decisions where there was disagreement, the computer had erred on the side of caution and generated a request for an urgent appointment in the clinic (false positives). In the majority of the cases, this had been due to its oversensitivity to flow studies. This appears to be a limitation of a rule-based system, wherein even a slight deviation from normal values triggers a response from the program even though it is not clinically worrying. The rules could be reset according to the opinion of individual consultants or units, but the limitations of a rule-based system are more likely to be overcome with the use of an artificial neural network for the program. We are currently in the process of developing such a network. An artificial neural network is a piece of software that can 'learn' how to classify patients the same way as an expert. It is subjected to a teaching data set, which comprises the input data — PSA, age, dipstick result, Q_{max}, residual urine, creatinine, IPSS and also the outcome — namely 'urgent' or 'routine'. The network then builds weighting factors that allow it to replicate the reasoning in the classification of future patients. It was initially tested on 60 patients and we found an agreement between the program and the consultant's decision in 52 patients and disagreement in eight patients. Further training of the neural network is required. Currently, we are training a network using the software by Radford M. Neal for flexible Bayesian modelling.[12]

Using PowerPoint screens, we have built a 'help' section that the patients can access at any point to learn about prostate disease. Section headings include, 'what is the prostate', 'what is the PSA test', 'what are the treatment options', etc. This is entirely driven by the patient who can view as much or as little information as he wishes.

This paper also aims to increase the awareness among doctors about the potential roles for computers in medicine and to encourage the further evaluation of their use.

Conclusion

We have a novel user-friendly program using routine MS Office applications, which has potential to improve efficiency and reduce constraints on time and staffing in the urology outpatients.

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