A Linux-based anaesthesia workstation.[1]

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Introduction

This talk describes our experience of developing a Linux-based anaesthesia information management system (AIMS) as part of a research program [1]. During 2003–2004 our original MS-DOS program [2] was rewritten for the Linux operating system using open-source tools. Electrical safety was overseen by the Department of Medical Physics. The default screen gives a continuous trend display of measured and derived parameters. Pull-down menus allow the inputting of drugs and events via mouse and/or keyboard entries. The system also offers 'help' and some decision support, and automatically prints out the Anaesthesia Record at the end of the operation in a form suitable to be placed directly into the clinical notes. An example screenshot and MAC-widget detail is shown in Figure 1.

Materials and methods

Data acquisition and display module

This is written in C/C^{++} and uses the Qt GUI library (standard with Linux systems). Serial-port data was accessed at 5 sec intervals from a Datex S/5 anaesthesia monitor and displayed in both trend and tabular formats on the screen, and saved to disk. It uses a modular driver system so that new monitor types can be added. Its configuration script system permits screen layouts and other parameters to be easily customised to local requirements.

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[1] Anaesthesia Workstation Project: http://www.nickalls.org/dick/xenon/rwdnXenon.html
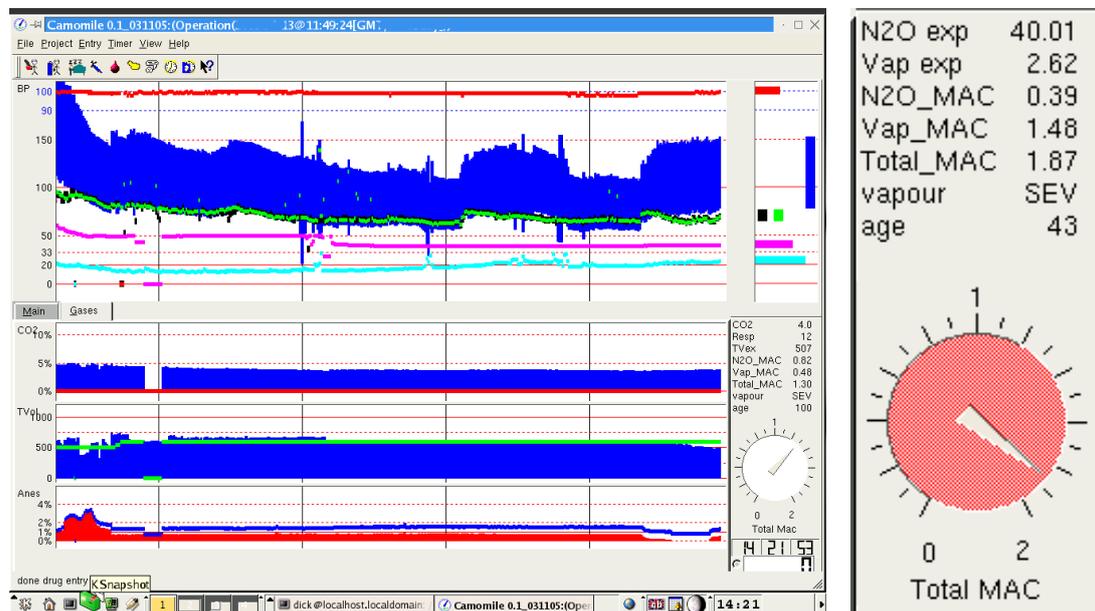ESCTAIC: http://www.esctaic.org/

FIGURE 1.

Trend-data screenshot (left) and real-time age-corrected MAC-widget display (right) of data from a Datex S/5 monitor. If the age-corrected MAC falls outside the set valid range it triggers both audible and visual alarms (turns the dial of the MAC-widget red). (images © Nickalls and Dales 2001–2010)

MAC display widget

In order to better gauge depth of anaesthesia [3, 4] the screen display incorporates a real-time age-corrected MAC display widget (Figure 1), which is positioned in the lower right part of the main display screen. The MAC-widget displays the current age-corrected MAC value, and implements an alerting colour change (to red) to warn of an out-of-range value, and hence greatly facilitates the avoidance of inadvertent awareness of the patient under anaesthesia.

Diabetes alert module

This is a Perl script which makes use of the Linux Kalarm utility. Tk widgets are used to present a menu which allows the user to quickly set special alerts to prompt regular monitoring of blood glucose. A 'help' system allows the user to access protocols for the insulin management of diabetic patients during major surgery.

Drug-menu module

This is a pull-down drug menu system which incorporates the standard NHS Dictionary of Medicines and Devices (DM+D) EU drug-list database [5]. The NHS listing currently consists of about 2000 drug names and preparations, and is updated weekly. Of the various subsets of the NHS drug database which are available for download we found

the Virtual Therapeutic Moieties (VTM) files to be the most useful, since these held the comprehensive list of standardised drug names and little else. Since this is a very large downloadable XML database, we wrote a Perl script to automatically convert the XML files into a format suitable for us to easily import into our system, with modifications as necessary.

Printing and data output module

Data output is generated using Perl scripts which coordinate data manipulation, graph plotting (using GNUplot), and typesetting (using LaTeX) [6]. Two output formats are used, as follows:

1. A paper Anaesthetic Record suitable for the patient notes, including the graphic trends and keyboard entries (events, procedures, drugs given, etc.), which is printed in the operating theatre at the end of anaesthesia.

2. A comprehensive HTML format allowing easy access to the data files, graphs, programs and coordinating scripts.

Results / Discussion

This Linux prototype started being used clinically in the thoracic operating theatre in 2004, and was found easy to use by both consultant and trainee anaesthetists. It was extremely useful both clinically and medico-legally.

References

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4. Nickalls RWD and Mahajan R (2010). Awareness and anaesthesia: think dose, think data. *British Journal of Anaesthesia*; 104, 1–2. http://dx.doi.org/10.1093/bja/aep360

5. www.dmd.nhs.uk/dictionary/

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