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Reliability engineering
Part 2: case study of syringe drivers

Dr Peter Clowes (NHS Grampian, Aberdeen) provides the second part of his feature on reliability engineering with a case study of syringe drivers using Weibull analysis.

Following on from the discussions in Part 1 (Some Fundamentals of Reliability Engineering), the results of a case study of syringe drivers using Weibull analysis are presented.

Syringe drivers are much used and very valuable pieces of medical electronic equipment. They are used to intravenously infuse a great range of solutions, often containing powerful drugs. For reasons of safety, such infusions must be accurate, both with respect to rate-of-delivery and in the total amount of solution delivered. Often syringe drivers are used on critically-ill patients and great reliance is put on their functioning properly.

The Weibull parameters for four syringe driver models are derived, and tabulated, and conclusions made as to the reliability of each. Additionally, it is shown that Weibull analysis can be used on small datasets, and that reasonable predictions of reliability can still be made, despite the small sample size.

DATA-SOURCE AND METHOD OF DATA-EXTRACTION

Data used in this analysis is either from the NHS Grampian Medical Electronics Equipment Database or with kind permission from the NHS Tayside Database. Table 1 provides a summary of the syringe driver entries in the NHS Grampian Database. For each item on the Database the time-to-first-failure (days) was calculated by examining the Repair Log. In some cases equipment was modified or received software upgrades following installation; these entries were ignored, and only true equipment failures, i.e. un-scheduled removals from service, were logged. For equipment that has not yet failed, the survival time (days) is logged.

THE RELIABILITIES OF FOUR TYPES OF SYRINGE DRIVER USING WEIBULL ANALYSIS

Figure 1 shows the Weibull plot for the estimate of probability of failure function $F(t)$ for the IVAC P3000 syringe driver; similar plots were made for the other three syringe drivers, and the Weibull parameters are all tabulated in table 2. Having the Weibull parameters for all four syringe drivers altogether makes comparisons easier.

For best reliability, the characteristic life parameter $\eta$ should...
be large, as this is the expected time for two-thirds of the equipment to fail; and the shape parameter $\beta$ should be small, as this describes the deterioration of equipment with age, a lower value of $\beta$ indicating less deterioration with age. However, values of $\beta < 1$ can indicate ‘burn-in’ failures, possibly showing that the product has not been properly cycled before being issued.

From table 2, it can be seen that the earlier models of syringe driver, the IVAC P1000 and the IVAC P3000, have significantly longer characteristic lives, i.e. the time at which 63.2 per cent of units fail, than those of the later models, the Asena GH and the BBraun Perfusor. The shape parameters of the older models are also smaller than those of the newer models, indicating better ageing performance. Some possible explanations for the apparent differences in reliability are offered below.

The earlier simple syringe drivers were robustly engineered, with a metal housing and a well-supported screw mechanism. They were also electronically simple and easier to use. Admittedly they lacked the sophistication of the modern devices, but in most cases provided adequate functionality.

The two modern syringe drivers are functionally complex, and have options that offer desirable features such as a ‘drugs-library’; however, it is not the introduction of more electronic sophistication that has made these models less reliable, but inherent mechanical problems.

Most of the first-time failures in the modern syringe drivers were due to mechanics, and not electronics. The shift to ‘plastics’ and, in both models, a design of drive-mechanism that now sits to the side of the main unit, have resulted in a more flimsy construction. The long-term effects of ultra-violet rays on the plastic possibly weaken it; and the drive mechanism to the side of the main unit allows an increased incidence of collision with other obstacles. The process of loading of the syringe into the later models is also more difficult. All these factors may have had detrimental effects on the reliability of the more modern syringe drivers.

One final consideration is that the present demands on the Health Service mean that equipment is more heavily used than a decade ago, and
this may well account for some of the apparent decline in reliability of the modern equipment over the older.

The following section discusses mean time to failure values (MTTFs) obtained from failed units only and shows how Weibull analysis provides a better estimate of reliability than calculations based on failed-data alone.

**MTTF Data and Weibull**

The characteristic life $\eta$ is related to the mean time to fail (MTTF) by the following relationship:

$$\text{MTTF} = \eta \Gamma(1 + 1/\beta)$$  \hspace{1cm} (1)\footnote{where: $\Gamma(z)$ is the gamma function defined by: $\Gamma(z) = \int_0^\infty t^{z-1} e^{-t} \, dt$; with $z = 1 + 1/\beta$.}

The gamma function can easily be evaluated using MATLAB® or similar software. The values of MTTF calculated using the gamma function are shown in column 6 of table 3.

If instead of adopting the methods of forming the estimation of probability of failure using either Auth’s method\footnote{Auth’s method} or Benard’s equation\footnote{Benard’s equation} and previously explained in Part 1, section 4, the MTTF value is calculated using failed-data only in the equation: $\text{MTTF} = \frac{t}{\sum n_i \eta_i / \sum \eta_i}$, then an under-estimate of MTTF results. This can clearly be seen in column 7 of table 3, where the MTTF estimates using $\text{MTTF} = \frac{t}{\sum n_i \eta_i / \sum \eta_i}$ all show significantly lower values than the Weibull-derived values (shown in column 6).

The BBraun data from NHS Grampian is from a small sample, so the accuracy of the prediction of the MTTF is questionable; however, Weibull is noted for its accuracy in these cases. In the next section, the predictions of MTTF from the NHS Grampian data are presented alongside additional data obtained from NHS Tayside.

**The Weibull Predictions for Small Samples**

Weibull is extensively used in predicting aircraft reliabilities. Such an industry thankfully has very few catastrophic failures; nevertheless, the...

### TABLE 2

<table>
<thead>
<tr>
<th>Syringe driver: manufacturer / type (analysis performed)</th>
<th>Review quantity (N)</th>
<th>Quantity failed (k)</th>
<th>Scale parameter ((\eta)) (days)</th>
<th>Shape parameter ((\beta))</th>
<th>Weibull distribution function (F(t))</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVAC / P1000 (multi-censored)</td>
<td>146</td>
<td>129</td>
<td>2,620</td>
<td>1.35</td>
<td>(1 - \exp(-t/2620)^{1.35})</td>
</tr>
<tr>
<td>IVAC / P3000 (singly-censored)</td>
<td>36</td>
<td>32</td>
<td>2,120</td>
<td>1.22</td>
<td>(1 - \exp(-t/2120)^{1.22})</td>
</tr>
<tr>
<td>Cardinal (Alaris) / Asena GH (multi-censored)</td>
<td>169</td>
<td>101</td>
<td>1,370</td>
<td>1.55</td>
<td>(1 - \exp(-t/1370)^{1.55})</td>
</tr>
<tr>
<td>BBraun / Perfusor 8713030 (singly-censored)</td>
<td>31</td>
<td>5</td>
<td>560</td>
<td>2.10</td>
<td>(1 - \exp(-t/560)^{2.1})</td>
</tr>
</tbody>
</table>

**TABLE 2.** Weibull parameters derived from: time-to-first-failure and total-run-time data.

### TABLE 3

<table>
<thead>
<tr>
<th>Syringe driver: manufacturer / type</th>
<th>Review quantity (N)</th>
<th>Quantity failed (k)</th>
<th>Weibull parameters</th>
<th>Weibull-derived MTTF</th>
<th>MTTF using failed data only: (\mu = \eta \Gamma(\beta))</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVAC / P1000</td>
<td>146</td>
<td>129</td>
<td>2,620</td>
<td>1.35</td>
<td>2,402</td>
</tr>
<tr>
<td>IVAC / P3000</td>
<td>36</td>
<td>32</td>
<td>2,120</td>
<td>1.22</td>
<td>1,985</td>
</tr>
<tr>
<td>Cardinal (Alaris) / Asena GH</td>
<td>169</td>
<td>101</td>
<td>1,370</td>
<td>1.55</td>
<td>1,232</td>
</tr>
<tr>
<td>BBraun / Perfusor (NHS Grampian)</td>
<td>31</td>
<td>5</td>
<td>560</td>
<td>2.10</td>
<td>496</td>
</tr>
</tbody>
</table>

**TABLE 3.** The Weibull-derived values presented alongside the failed-units MTTF values.
SCOPE | FEATURE

TABLE 4

<table>
<thead>
<tr>
<th>Data source Manufacturer / type (analysis performed)</th>
<th>Review quantity (N)</th>
<th>Qty Failed (k)</th>
<th>Scale parameter (η) (days)</th>
<th>Shape parameter (β)</th>
<th>Weibull estimate of MTTF (µ)</th>
<th>Weibull distribution function F(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHS Grampian BBraun / Perfusor (singly-censored)</td>
<td>31</td>
<td>5</td>
<td>560</td>
<td>2.10</td>
<td>496</td>
<td>$1 - \exp\left(-t/560\right)^{2.1}$</td>
</tr>
<tr>
<td>NHS Tayside BBraun / Perfusor (multi-censored)</td>
<td>81</td>
<td>50</td>
<td>730</td>
<td>1.60</td>
<td>654</td>
<td>$1 - \exp\left(-t/730\right)^{1.6}$</td>
</tr>
</tbody>
</table>


A FIGURE 2. Weibull plots for the BBraun syringe drivers: the singly-censored small sample data from NHS Grampian and the multi-censored large sample from NHS Tayside.

few catastrophic failures that do occur give valuable information. It has been found from many studies on aircraft failures that Weibull is a good predictor of reliability, despite the sparse data available.

In the case of the NHS Grampian BBraun syringe-driver analysis using only five failures, the Weibull parameters, scale $\eta$ and slope $\beta$, indicated poorer reliability when compared to the other syringe driver models. In order to offer confidence in the predictions made from the small sample, Medical Physics at Ninewells Hospital, Dundee, were asked to provide their first-time-to-fail data, and their survival-time data on their BBraun syringe drivers. Thanks to the help of Dr George Corner, Head of Instrumentation, and Mr Robert McKinnes, Senior Medical Electronics Technologist, a comparison between the results of the short data set (NHS Grampian) with the large data set (NHS Tayside, Dundee) can be presented; see table 4.

Figure 2 shows the Weibull plots for the singly-censored small sample data from NHS Grampian and the multi-censored large sample from NHS Tayside.

The NHS Grampian small sample data gave: $\eta = 560$ days and $\mu$ (MTTF) = 496 days, and that of the NHS Tayside data gave: $\eta = 730$ days and $\mu$ (MTTF) = 654 days.

The characteristic life value from the small sample was a 20 per cent under-estimate of that of the large sample, and the MTTF of the small sample was a 24 per cent under-estimate of the larger sample. Despite the small sample size of the NHS Grampian data, a reasonably good estimate of characteristic life and MTTF has been made.

CONCLUSIONS

The methods of failure-statistics analysis shown here use all the observed data available. The methods presented (that of determining the estimate-of-failure function $F(t)$ using either Benard’s equation for singly-censored data or using Auth’s equation for multi-censored data), coupled with the use of Weibull graph plotting techniques, provide a better method of predicting reliability than using failed-data only.

To demonstrate the superiority of the combined methods of estimate of failure and Weibull analysis over the simpler failure-only method, the
BBraun syringe driver results are reviewed.

The MTTF values derived from the failures only are: 216 days (NHS Tayside) and 162 days (NHS Grampian).

Bearing in mind that the MTTF value is the time in which almost two-thirds of the units (63.2 per cent actually) are expected to fail, clearly the non-Weibull predictions are inaccurate; examination of the larger data-set (Dundee) showed that only 11 units out of 81 units failed at 216 days or less.

The Weibull-derived MTTF (Dundee) gives the value of 654 days, at which 40 units had failed and 41 units non-failed. This is still not at the two-thirds level; however, many of the syringe drivers are fairly new and have only run for a short period of time, less than 730 days characteristic life period, thus distorting the expected number of failures. Nevertheless the observed number of failures of 40 units out of 81 is significantly nearer to reality than the 11 failures predicted using only failed-data.

REFERENCES


ABOUT THE AUTHOR

Dr Peter Clowes, Clinical Scientist, MIPEM, C.Eng., joined NHS Grampian, Aberdeen, in March 2004 to work in Medical Equipment Management, where he has special responsibilities for: infusion devices, patient-monitoring equipment and medical equipment strategies, including reliability analysis. Prior to joining the NHS, he had worked in the oil and gas sector, and was primarily involved with design and development of sub-sea control systems. His last post was with Ocean Resource Limited, Chepstow, where he held the dual responsibilities of Chief Control Systems Engineer and Chief Reliability Engineer. It is his interest in reliability analysis and his present involvement with medical electronic equipment that have spurred the production of this paper.

CORRECTION NOTE

Page 12, middle column:
2. Rank: this is simply the row number, starting at 1, up to n; n = 169 in this example.
SHOULD READ:
2. Rank: this is simply the row number, starting at 1, up to n; n = 11 in table 5.
Mary Arbuthnot (Science Council) recently interviewed the Science Council’s Diana Garnham and Alisdair Orr to ask for their views on revalidation.

The Science Council was established by Royal Charter in 2003 with the objective to advance science and its applications for public benefit. Under Diana Garnham’s leadership, the Council sees its core remit as helping to build public trust in science and scientists. Garnham, along with her Deputy Registrar Alisdair Orr, believe their Chartered Scientist designation (CSci) is central to that goal.

THE CASE FOR REVALIDATION

I sat down recently with the Science Council’s Chief Executive Diana Garnham and Deputy Registrar Alisdair Orr to get their perspective on the revalidation issue as it pertains to their Chartered Scientist (CSci) programme. The full picture, as I found out, is a complex and multifaceted one. The following article is a summary of the most salient points – both macro and micro – that I took away from our conversation.

HOW DID THIS ALL BEGIN?

The Science Council was established by Royal Charter in 2003 with the objective to advance science and its applications for public benefit. Under Diana Garnham’s leadership, the Council sees its core remit as helping to build public trust in science and scientists. Garnham, along with her Deputy Registrar Alisdair Orr, believe their Chartered Scientist designation (CSci) is central to that goal.
contentious – whether swine flu, climate change, an ageing population, the list goes on – the Science Council offers their CSci designation to scientists as an anchor in an often stormy sea of conflicting agendas and public mistrust. At CSci’s heart – arguably the lifeblood that keeps it relevant – is the concept of ongoing revalidation.

PROFESSIONALISM AND TRUST
‘CSci and revalidation are part of the process of addressing public concern in the integrity of science and gaining the trust and respect of your scientific peers,’ says Garnham. ‘How can you ask the public to trust scientists without this? The qualities of a professional scientist are embedded in what CSci is – a mark of current competence and commitment to codes of professional conduct and ethics.’

Public trust for most things is in short supply. Just ask Viki Cooke, Chair of Opinion Leader, who ran a recent seminar entitled Has Trust Gone Bust? ‘We’ve moved from an age of deference to reference, where people are more likely to trust the advice of their friends and family versus that of experts,’ says Cooke. ‘There is a toxic debt of trust and sense of lack of accountability… people are seen to get away with things.’ Garnham agrees and wants professional bodies to be more outward-facing. ‘What do the public need from scientists?’, Garnham asks, implying it’s a question not asked enough. ‘Some people think you can tell the public, “we’re clever, trust us”, but behind trust are transparency and accountability.’

REVALIDATION: THE BASICS
Garnham and Orr believe the Science Council’s Chartered Scientist qualification (CSci) – launched in 2003 and currently approaching 15,000 registrants across 21 Licensed Bodies – is a significant step towards winning back public confidence in the UK’s thousands of science professionals.

A key component of the Chartered Scientist status has always been mandatory revalidation, or the process by which a regulated professional periodically has to demonstrate that he or she remains fit to practise. This ensures professionals don’t become static in their careers by requiring them to practise and record a variety of ‘continuing professional development’, commonly referred to as CPD.

The Science Council defines CPD as ‘the means by which professionals maintain, improve and broaden their knowledge and skills, and develop the personal qualities required in their working lives’. What qualifies as CPD is virtually limitless and falls roughly into five broad categories, including: (1) work-based learning; (2) professional activity; (3) formal/educational; (4) self-directed learning; and (5) other, i.e. voluntary work.

A little known but surprising piece of trivia is that the NHS is the largest employer of scientists in the UK. Acknowledging their prominence in the regulatory agenda, the Science Council maintains a regulatory interface with the related Health Professions Council, who alone regulates in excess of 200,000 professionals. While accurate numbers don’t exist to show the total number of UK professionals involved in some form of ongoing regulation (CPD, revalidation etc.), looking at HPC’s figures combined with the multitude of other UK professional bodies it seems reasonable to speculate this number could easily be over a million.

The Science Council’s synergistic relationship with HPC has resulted in their modelling CSci’s new 2008 CPD standards on HPC’s existing guidelines. These five requirements state that all registrants must:

- maintain a continuous, up-to-date and accurate record of their CPD;
- demonstrate that their CPD activities are a mixture of learning activities relevant to current or future practice;
- seek to ensure that their CPD has benefitted the quality of their practice, and
- benefited the users of their work;
- present a written profile containing evidence of their CPD on request.

In addition to these standards, CSci also outlines five broad areas of competencies that Chartered Scientists are expected to demonstrate through a combination of their knowledge and experience. These include skills like the ability to deal with complex scientific issues and to exercise self-direction and originality in solving problems.
**SCOPE | FEATURE**

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**SCOPE | FEATURE**

**REVALIDATION: THE FUTURE**
The 2008 Science Council review of CPD requirements led not only to new CPD standards, but also, significantly, a move from a five-year revalidation requirement to annual revalidation phased in by 2011. This means moving forward Chartered Scientists must keep an accurate record of their CPD achievements for submission each year, subject to scrutiny by auditors, in order to remain active on the Register.

This significant policy change is the result of a general consensus by the Science Council’s Licensed Bodies that a five-year gap for revalidation is too long and causes scientists to procrastinate recording their CPD until the last minute. Garnham and Orr hope that a two-year transition to annual revalidation will reduce this bottle-neck effect and be ample time to make regular CPD recording both habit-forming and hassle-free.

**REVALIDATION: THE CONTROVERSY**
But CPD and revalidation are not without controversy. Perhaps unsurprisingly, there has been resistance to change, and a backlash against revalidation amongst some members of the CSci community who perceive it as time-consuming, ineffective, prone to dishonesty and condescending.

While acknowledging the validity of their concerns, Orr hopes to slowly win over hearts and minds. ‘There are misconceptions about CPD, which is evolving,’ he says. Orr wants Chartered Scientists to develop a more reflective practice through engagement in CPD, which he believes most scientists do on a daily basis without even realising it. ‘There is a technical and conceptual side to revalidation and CPD,’ he explains. ‘The old CPD system relied heavily on the technical “input-based CPD” built around points earned for hours invested attending industry conferences or reading journals, which while useful has its limitations. But now there is a more reflective “output-based CPD” which is about measuring the benefits of CPD to your practice in a much broader way. For example, if you’re a psychologist who goes on a statistics course, you can demonstrate how you’ve used what you’ve learned to benefit your practice, even though statistics isn’t directly related to your field.’

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**REVALIDATION: BIG BROTHER?**
Understandably, increased scrutiny over the auditing period, as well as disciplinary complaints (peers reporting the infractions of their colleagues), can make many Chartered Scientists nervous.

But Orr stresses that the auditing process is not intended to catch hard-working scientists out, but instead to maintain CSci’s integrity and highly regarded reputation. ‘I want to reassure people that if they’re still in employment it’s probably because they’re valuable and doing CPD without even realising it,’ he says.

Registrants should be aware that the audit will be peer-reviewed: assessors will always be Chartered Scientists like themselves, not some highly-paid consultant without any knowledge of the field. Once the revalidation transition is complete, a sample audit of 2.5 per cent of registrant’s returns will be scrutinised by a minimum of two trained assessors. They will ask questions like: ‘Has your CPD been a mixture of different learning activities? Have you shown the benefits to your work? Has the CPD improved the quality of your practice?’

Thankfully for those Chartered Scientists required to submit their CPD log to another registration body, the Science Council has signed up to the Hampton Regulations, which mean CSci’s don’t have to double up on paperwork. The Hampton principles also stipulate that any regulatory audit should be responsive to risk and increased only if a sample group is worse than expected. It will then be up to individual Licensed Bodies to decide if a poor audit is worthy of an internal review.

While there might be a tendency to focus on the negative perceptions of revalidation, Orr believes the positive benefits to the individual far
ultimately means greater job satisfaction and a deeper commitment to one’s company and colleagues. On an individual level, regular tracking of one’s CPD progress isn’t just for revalidation – chances are most scientists will use this data to enhance and keep their CVs, bios and websites up-to-date too.

Another benefit of CSci is its transferability. Increasingly scientists are involved in interdisciplinary work and don’t identify themselves with just one body of professionals (i.e. engineers, chemists or biologists). Unlike most other chartered designations, if scientists decide to transfer between license bodies their status doesn’t change; they simply take their CSci with them. CSci is the scientific equivalent of the Euro, a currency of professional recognition that transcends the borders of any one discipline and empowers scientists to be collaborative instead of shutting them in their box… whether they are a biologist, food scientist, engineer or psychologist.
**SIMPLE LINEAR REGRESSION: PREDICTING VALUES OF VARIABLES**

**Dr Jenny Freeman and Dr Tracey Young** use simple linear regression to quantify continuous variables and predict the values of them from other known ones.

In the previous tutorial, we looked at using correlation to assess the strength of the linear relationship between two continuous variables. The correlation coefficient simply measures the strength of the linear association as a single number. No distinction is drawn between the two variables and no causation is implied. However, it is often of interest to quantify the relationship between two continuous variables, and given the value of one variable for an individual, to predict the value of the other variable. This is achieved using the technique known as simple linear regression. One variable is regarded as a response to the other predictor (explanatory) variable and the value of the predictor variable is used to predict what the response would be.

**SCATTER PLOTS**

As stated in the previous tutorial, when undertaking either a correlation or simple linear regression analysis it is important to construct a scatter plot of the data. The values of one variable are plotted on the horizontal axis (known as the x-axis) and the values of another are plotted on the vertical axis (y-axis). By drawing a scatter plot it is possible to see whether or not there is any visual evidence of a straight line or linear association between the two variables. It is possible for there to be a relationship between two variables but for that relationship to be not linear. In this case, correlation or simple linear regression analysis may not be the most appropriate methods to use. In addition a scatterplot provides a good way of examining the data and checking for outliers or odd values.

If it is known (or suspected) that the value of one variable (known as the independent variable) influences the value of the other variable (known as the dependent variable), it is usual to plot the independent variable on the horizontal axis and the dependent variable on the vertical axis. In the case of height and weight, as height determines weight, to an extent, and not the other way around, a scatterplot of weight against height would be plotted with height on the horizontal axis and weight on the vertical axis.

**SIMPLE LINEAR REGRESSION**

In the technique of simple linear regression a straight-line equation is used to model the relationship between the predictor variable and the response variable. The equation of the regression line is given by: $y = a + bx$

where:
- $x$ = independent / predictor / explanatory variable: variable that is used to predict the values of the response variable. This is plotted on the horizontal axis of a scatterplot.
- $y$ = dependent / response / outcome variable: variable being predicted by the model. This is plotted on the vertical axis of a scatterplot.
- $a$ = intercept. This is the point at which the regression line crosses the vertical (Y) axis. Strictly speaking this gives the value of the Y variable (dependent variable) when the X variable (independent variable) is zero.
- $b$ = regression coefficient. It is also known as the slope and it shows the average change in the Y variable (outcome) for a unit change in the X variable (predictor/explanatory variable).

$a$ and $b$ are calculated as follows:

$$b = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$

$$a = \bar{y} - b\bar{x}$$

**EXAMPLE: SIMPLE LINEAR REGRESSION OF WEIGHT AGAINST HEIGHT FOR TEN ELDERLY MEN**

Figure 1 shows the height and weight values for 10 elderly men. The data are given in Table 1.

Thus the regression equation for these data is:

$$weight = -82.25 + 0.9051 \times height$$

From this it can be seen that the slope coefficient was 0.9051, indicating that for every 1 cm increase in height there was an increase in weight of 0.9051 kg. Note that the value of the intercept is –82.25. Thus when height is zero, weight is –82.25 kg. Clearly this is nonsense and illustrates an important principle for regression analyses: they should never be used to predict values outside of the range of observations. However, within the range of the data the regression equation can be used to predict the values of the Y variable for particular values of the X variable. For example the estimated weight for an elderly man who was 180 cm tall is calculated as follows:

$$weight = -82.25 + 0.9051 \times 180 = 80.67 kg$$

**ASSUMPTIONS AND MODEL FIT**

Three important assumptions underlie a simple linear regression analysis as outlined in Box 1 and as with any statistical analysis it is important to check that they are valid and that the model fits the data adequately. The first assumption can be checked by constructing a scatter plot of the data (figure 1).

The final two assumptions can be checked by examining the residuals from the fitted model. Each $y$ observation has a residual associated with it; this is the difference between the actual observed $y$ value ($y_{ob}$) and the $y$ value predicted by the model (known as the fitted value ($y_{fit}$) (see table 2). In figure 1 for each point the residual is given by the vertical distance between that point and the fitted regression line. For example, for...
**FIGURE 1.** Scatter plot of weight against height together with the regression line.

**TABLE 1**

<table>
<thead>
<tr>
<th>Subject</th>
<th>x</th>
<th>x - ( \bar{x} )</th>
<th>((x - \bar{x})^2)</th>
<th>y</th>
<th>y - ( \bar{y} )</th>
<th>((y - \bar{y})^2)</th>
<th>((x - \bar{x})(y - \bar{y}))</th>
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<td>57</td>
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<td>-2.5</td>
<td>6.25</td>
<td>77</td>
<td>-0.5</td>
<td>0.25</td>
<td>1.25</td>
</tr>
<tr>
<td>4</td>
<td>183</td>
<td>6.5</td>
<td>42.25</td>
<td>89</td>
<td>11.5</td>
<td>132.25</td>
<td>74.75</td>
</tr>
<tr>
<td>5</td>
<td>178</td>
<td>1.5</td>
<td>2.25</td>
<td>93</td>
<td>15.5</td>
<td>240.25</td>
<td>23.25</td>
</tr>
<tr>
<td>6</td>
<td>188</td>
<td>11.5</td>
<td>132.25</td>
<td>73</td>
<td>-4.5</td>
<td>20.25</td>
<td>-51.75</td>
</tr>
<tr>
<td>7</td>
<td>180</td>
<td>3.5</td>
<td>12.25</td>
<td>83</td>
<td>5.5</td>
<td>30.25</td>
<td>19.25</td>
</tr>
<tr>
<td>8</td>
<td>182</td>
<td>5.5</td>
<td>30.25</td>
<td>86</td>
<td>8.5</td>
<td>72.25</td>
<td>46.75</td>
</tr>
<tr>
<td>9</td>
<td>163</td>
<td>-13.5</td>
<td>182.25</td>
<td>70</td>
<td>-7.5</td>
<td>56.25</td>
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<td>179</td>
<td>2.5</td>
<td>6.25</td>
<td>82</td>
<td>4.5</td>
<td>20.25</td>
<td>11.25</td>
</tr>
<tr>
<td>Total</td>
<td>1,765</td>
<td>0.0</td>
<td>558.50</td>
<td>775</td>
<td>0.0</td>
<td>1,148.50</td>
<td>505.50</td>
</tr>
</tbody>
</table>

**TABLE 1.** Calculation of regression equation for regression of weight on height of 10 elderly men.

\[
\overline{x} = 1765 / 10 = 176.5 \text{ cm} \quad \overline{y} = 775 / 10 = 77.5 \text{ kg} \quad b = 505.5 / 558.5 = 0.9051 \quad a = 77.5 - 0.905103 \times 176.5 = -82.25
\]

**BOX 1: Assumptions**

1. The relationship between the two variables should be linear.
2. The value of the response variable, \( y \), should have a Normal distribution for each value of the explanatory variable \( x \).
3. The variance (or standard deviation) of \( y \) should be the same at each value of \( x \), i.e. there should be no evidence that as the value of \( y \) changes, the spread of the \( x \) values changes.
the first observation in table 1, the actual weight is 65 kg and the predicted weight is 74.33 kg, thus the residual is given by 65 − 74.33 = −9.33 kg.

In order for assumption 2 to be valid the residuals should be Normally distributed. This is most easily checked by constructing a histogram of the residuals to check that this is approximately Normal (figure 2). With only 10 individuals it is difficult to definitively conclude that the residuals are Normally distributed, but given that they are spread out around a central peak it would appear to be reasonable to accept this assumption as being valid. In order to check assumption 3 it is necessary to do a scatter plot of the residuals against the predicted values. This should show a good spread with no obvious patterns (i.e. it looks random) as in figure 3.

**R**

The value of **r**$^2$ is often quoted in published articles and indicates the proportion (sometimes expressed as a percentage) of the total variability of the outcome variable that is explained by the regression model fitted. A well-fitting model will have a high **r**$^2$ and a badly-fitting model will have a low value of **R**$^2$. It is calculated as follows:

\[
\frac{\left(\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})\right)^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2 \sum_{i=1}^{n} (y_i - \bar{y})^2}
\]

Note that this is also the square of the correlation coefficient:

\[
\frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2 \sum_{i=1}^{n} (y_i - \bar{y})^2}}
\]

For the current example the value of **r**$^2$ is 0.398. Thus 39.8 per cent of the total variability in weight for the 10 men is explained by their heights.

**MORE THAN ONE EXPLANATORY VARIABLE**

Simple linear regression as described above involves the investigation of the effect of a single explanatory variable on the outcome of interest. However, there is usually more than one possible explanatory variable influencing the values of the outcome variable and the method of regression can be extended to investigate the influence of more than one explanatory variable on the outcome of interest. In this case it is referred to as

---

**TABLE 2.** Calculation of residuals from the fitted model.

<table>
<thead>
<tr>
<th>Actual height (m)</th>
<th>Actual weight (kg)</th>
<th>Predicted value = −82.25 + height * 0.9051</th>
<th>Residual (yobs − yfit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>173</td>
<td>65</td>
<td>74.33</td>
<td>−9.33</td>
</tr>
<tr>
<td>165</td>
<td>57</td>
<td>67.09</td>
<td>−10.09</td>
</tr>
<tr>
<td>174</td>
<td>77</td>
<td>75.24</td>
<td>1.76</td>
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<td>183</td>
<td>89</td>
<td>83.38</td>
<td>5.62</td>
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<td>178</td>
<td>93</td>
<td>78.86</td>
<td>14.14</td>
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<td>188</td>
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<td>87.91</td>
<td>−14.91</td>
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<td>180</td>
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<td>80.67</td>
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</tr>
<tr>
<td>163</td>
<td>70</td>
<td>65.28</td>
<td>4.72</td>
</tr>
<tr>
<td>179</td>
<td>83</td>
<td>79.76</td>
<td>2.24</td>
</tr>
</tbody>
</table>

**FIGURE 2.** Histogram of the residuals from the fitted model.
multiple regression, and the influence of several explanatory variables can be investigated simultaneously. This is beyond the scope of the current tutorial and will be covered in a subsequent tutorial.

SUMMARY: REGRESSION OR CORRELATION?
Regression and correlation are related methods (note that the $r^2$ coefficient is simply the square of the correlation coefficient!). As they are often presented together it is easy to get the impression that they are inseparable. In fact, they have distinct purposes and it is relatively rare that one is genuinely interested in performing both analyses on the same set of data. Regression is more informative than correlation. Correlation simply quantifies the degree of linear association (or not) between two variables. However, it is often more useful to describe the relationship between the two variables, or even predict a value of one variable for a given value of the other and this is done using regression. If it is sensible to assume that one variable may be causing a response in the other then regression analysis should be used.

FIGURE 3. Plot of the residuals from the model against the predicted values.
THE MONTE CARLO N-PARTICLE (MCNP) code was developed at the Los Alamos National Laboratory and can be used for modelling neutron, photon and electron transport. Consequently it can be used as a powerful tool in medical physics in areas such as radiation protection and dosimetry. The Visual Editor Consultants (VEC), based in the US, developed a visual editor for use with MCNP, funded by NASA. The software allows visualisation of 3D structures as they are created and includes wizards for defining cells, sources and material definitions. I was asked to investigate the use of MCNP for PET shielding calculations as part of my higher training. The VEC offer training courses on using MCNP with the editor and so I attended this recent course held in Las Vegas, with the flights funded through an IPEM bursary.

The course was a week long, computers were provided with the code and example problems installed (figures 1 and 2). A prior knowledge of MCNP was not required for the class. We were provided with manuals covering MCNP theory, how the visual editor worked and two problem books. A CD with the notes, code (for the example problems) and latest version of the visual editor were also handed out. The examples were heavily weighted towards the nuclear power sector, but helped those involved gain an understanding of the basics of MCNP and how the editor worked. Students were also free to bring in their own problems and discuss and develop them with Randy Schwarz (founder of VEC).

The first few days focused primarily on setting up the geometry of the shielding, before developing into sources, tallies, universes and lattices. For those new to MCNP, the editor is a very useful learning tool, allowing the user to create geometries very easily, use the wizards and watch the code appear in an input box on screen. This helped me familiarise myself with the MCNP code and, as I got more experienced, allowed me to easily edit or write my own code into the input box directly. There were, however, some parts of MCNP that were only briefly addressed and I found myself getting a bit lost at times. Since returning from the course and trying to do problems by myself, I have had to go back to basics and refer to the MCNP manual (provided by Los Alamos National Laboratory) with regards to tallies and sources in particular. When I mentioned this on my course evaluation form, Randy contacted me to say that if I have any questions or code that I have problems with, to email them to him for help. When I did, he replied the following day answering my questions with useful examples.
For current users of MCNP, the ability to immediately visualise the geometry of designs as they are inputted will, I think, prove very useful and aid in the task of spotting errors early on in the design process. There is also a useful feature that lets you plot the particle tracks so you can see potential weaknesses in shielding and if you have programmed your source correctly. Another feature is the option to import CAD files, which would vastly simplify the development stage when looking at room shielding problems.

While it has the potential to save a lot of time plotting geometries, the system frequently crashes, usually when the geometry is not quite right. This has been very frustrating initially; however, as I have gained more experience with the editor and its quirks it is running much more smoothly, although I would advise people to save their work frequently.

The course venue was a pleasant hotel just off the main Strip in Vegas. If you like casinos, drinking, shows, general excess and a lot of tack, the Strip is the place to go. It is, however, all about money, which you need in order to see the more glamorous side of the city (figure 3). If you ever find yourself in the area though, forget the rest – the Grand Canyon is an absolute, amazing, spectacular must.

Overall the course offered a good introduction to MCNP and in particular the visual editor, certainly enough to get me going on looking at shielding problems, although more MCNP theory would be beneficial.

If people are interested in taking an MCNP/Visual Editor course (beginner, intermediate or advanced), Randy will (and is quite keen to) come across to the UK. He needs a class of at least 6 people ($2,000 each for a week’s course). For more information and contact details see http://www.mcnpvised.com/. He has also recently partnered with the development team at Los Alamos to deliver training workshops, including some to be held in Europe in 2010, again charged at $2,000 (if booked early). These may cover tallies and sources in more detail. A copy of the code is required before attendance however, and this can be obtained from the Nuclear Energy Agency (NEA) who distribute the code in Europe. You can also book the European courses through the NEA for 2,000 euros, so check the exchange rates first!
THE ANNUAL RPA UPDATE MEETING, organised by the Institute of Physics in Engineering and Medicine (IPEM), Radiation Protection Special Interest Group, was held on 16th June at Austin Court in Birmingham.

Eddy Rafiqi (Queen Elizabeth Hospital, Birmingham) opened the day by welcoming everyone to Birmingham, explaining that the programme included topics requested by IPEM members.

MORTALITY AND CANCER RISKS FOLLOWING OCCUPATIONAL RADIATION EXPOSURE: 3RD ANALYSIS OF THE UK NATIONAL REGISTRY FOR RADIATION WORKERS (NRRW)

The NRRW was set up in 1976 in order to obtain data on the risks from protracted or low dose radiation exposures. The organisations that participate in the NRRW are in the nuclear, research and industrial sectors. Colin Muirhead (Health Protection Agency, Didcot) presented the results of the third analysis, which, funded by the Health and Safety Executive, provides the most precise estimates to date of mortality and cancer risks following occupational radiation exposure and strengthens the evidence for raised risks from these exposures. The results show the cancer risk estimates to be consistent with values used to set radiation protection standards, both for leukaemia and for all other cancers combined, and exclude the possibility of radiation risks being more than a few times higher than existing estimates. Further details of the analysis can be found at: www.nature.com/bjc.

LESSONS LEARNT FROM EXCEEDING A DOSE LIMIT IN THE CATH LAB

Matthew Dunn (Nottingham University Hospitals NHS Trust, Nottingham) reported on the lessons learnt when a Senior Consultant Radiologist performing hepato-biliary interventional procedures exceeded a dose limit. His doses were erratic, occasionally very high and annually well above the classification level of 150mSv. Although his doses were higher than those of his colleague undertaking similar procedures and did not correlate well with his workload, he was unable to offer any explanation! In 2001, the dose to his left hand exceeded 500mSv, the Health and Safety Executive (HSE) were notified and an action plan was drawn up. Matt’s conclusion emphasised the need for proper risk assessments to be undertaken and the need to ‘monitor’ any monitoring arrangements which are in place (no-one should be overexposed). He also indicated that intervention by the Radiation Protection Adviser at an early stage can dramatically reduce doses. Finally, the Radiation Employer has overall responsibility for compliance with the regulations and should be reminded of this obligation.

DEFICIENCIES IN BARRIER SHIELDING

Gareth Iball (Leeds General Infirmary, Leeds) reminded us that the Radiation Employer must contact one or more suitable Radiation Protection Advisers (RPA) in respect of the items listed in Schedule 5 of the Ionising Radiations Regulations 1999 (IRR99). He also reminded us of the additional RPA ‘tasks’ in Regulations 8 (restriction of exposure), 10 (maintenance and examination of engineering controls and personal protective equipment) and 31 (duties of manufacturers of articles for use in work with ionising radiation). Gareth briefly described the stages taken in planning a new CT room, a simple method for checking the level of protection and any discontinuities (‘hotspots’), and the solutions to problems found. In summary, it is important to check the shielding, to measure the dose rate through barriers as a visual check will not identify all the deficiencies, and to state the design conditions and dose constraints early and worry about every other room that has not been checked in this way!

CO-OPERATION BETWEEN EMPLOYERS IN THE HEALTH SERVICE

In today’s NHS culture, ‘employers’ within different organisations are required to work together, e.g. those within NHS Trusts, Primary Care Trusts, Independent Sector Treatment Centres, Service Contractors, and so on. In her presentation, Claire-Louise Chapple (Newcastle General Hospital, Newcastle) focused on the ‘radiation employer’, i.e. the main duty holder, as required by the Ionising Radiations Regulations 1999 (IRR99) and the Ionising Radiation (Medical Exposure) Regulations 2000 (IR(ME)R2000). Is the ‘radiation employer’ the owner of the premises, the owner of the equipment, the employer of the staff member operating the equipment, the employer controlling the equipment, the employer providing the service or is it all of these people? Perhaps we should ask ‘who is responsible’ for notification of work with ionising radiation, carrying out risk assessments, providing local rules, organising QA, providing the employer’s IR(ME)R procedures, investigating/reporting ‘exposures much greater than intended’ and for things going wrong? Claire-Louise provided a number of examples and ended with a plea for more definitive guidance on the interpretation of ‘employer’ and the requirements for ‘co-operation’ in today’s NHS culture.
RISK ASSESSMENTS – A REFRESHER
Michael Nettleton indicated that when HSE carry out inspections, the two regulations most commonly used are Regulation 7 (Prior Risk Assessment) and Regulation 8 (Restriction of Exposure). The regulations say that there must be a ‘suitable and sufficient’ assessment of the risk to any employee …’, that ‘all hazards with the potential to cause a radiation accident have been identified’ and that ‘the nature and magnitude of the risks to employees … have been evaluated’. During inspections, he has found risk assessments which are ‘suitable and sufficient’, those that have been ‘done (mentally), but not recorded’ and those which haven’t been done at all! He concluded by saying that a risk assessment must be undertaken (and documented), any control measures must be implemented and it must be reviewed! NB: risk assessments are also required under the Management of Health and Safety at Work Regulations 1999 (Regulation 3).

ETHICS APPLICATIONS – THE PROBLEMS AND ONE SOLUTION
Giles Morrison (Sheffield Teaching Hospitals, Sheffield) reported that specific requirements for the use of radiation sources have been included in the Integrated Research Application System (IRAS) online ethics application form. The publication of revised guidance for ‘approval of research involving ionising radiation’ in 2008 has resulted in a general improvement of Multi-Centre Research Ethics Committees (MREC) applications and a greater confidence in local compliance with IR(ME)R 2000 for research. However, the requirements of local research departments for corporate governance, and the demands of national and international research organisations, continue to throw up problems. Chief and principal investigators, clinical radiation and medical physics experts are still learning their roles within the guidance! James Harries (Oxford Radcliffe Hospitals, Oxford) went on to describe the use of local computer software for calculating the doses and risks associated with each application.

AN UPDATE ON THE REQUIREMENTS OF THE RADIOACTIVE SUBSTANCES ACT
Chris Englefield (Environment Agency, Warrington) reported that significant changes are imminent to the Radioactive Substances Act 1993. New Environmental Permitting Regulations (EPP2) are likely to replace 95 per cent of the requirements of the primary legislation and the long-awaited review of exemption arrangements by government is nearing completion. The regulations will increase transparency and flexibility in ways that will hopefully lighten the burden on the medical sector, without reducing the environmental standards and outcomes. They will also help the UK develop its strategic approach to radioactive waste management in the long term. We should read the consultation documents for EPP2 and exemption order review, consider how the proposals will affect us and pass on our comments to the Department of Energy and Climate Change (DECC).

REQUIREMENTS OF THE TRANSPORT REGULATIONS (INCLUDING THE ROLE OF THE DANGEROUS GOODS SAFETY ADVISOR)
David Rowe (Department for Transport, London) reported that the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009) came into force on 1st July 2009 (Statutory Instruments 2009/1348). Carriage must be undertaken in accordance with the European Agreement Concerning the International Carriage of Dangerous Goods by Road 2009 (ADR 2009). No further changes to CDG are proposed, but the ADR will continue to be subject to a 2-year review. David outlined the derogations relating to fire extinguishers, the alternative to the orange plates and the crossing of public roads. He went on to talk about Labelling (ADR Chapter 3.2), Emergency Arrangements (CDR: Regulation 24 and Schedule 2, and ADR 2009: Section 5.4), Certification of Expired Type A Containers (ADR Chapter 6.4), Renewal of Special Form Material Certificates, Security Provisions (ADR Sections 1.10.1 and 1.10.2), Dangerous Good Safety Advisers (CDG 2007, Regulation 43 and ADR 2009), Vehicle Equipment (ADR Chapter 8.1), Quality Assurance and Training (ADR Section 1.7.3), Training (ADR Sections 1.3.2.1, 1.3.2.2, 1.3.2.3, 1.3.3 and 1.7.2.5) and Compliance Assurance. At the end of his presentation, David identified current problems relating to incomplete consignment notes and vehicle equipment, the lack of emergency arrangements, incorrect marking and labelling of packages, inadequate justification of package design approval and package contents/activity and counterfeit packages/spare parts. Finally, to round off the presentations, David asked for completed Department for Transport questionnaires to be returned at the earliest opportunity.

THANKS TO THE FOLLOWING SPONSORS OF THE MEETING
The meeting was sponsored by Mirion Technologies Dosimetry Services Division, Pycko Scientific Ltd, Qados and Southern Scientific Ltd.■

SOUTH WEST TRAINEE AND SUPERVISOR MEETING
ALEX MORRIS Part I Trainee, Plymouth Hospitals NHS Trust

SALISBURY DISTRICT HOSPITAL 9th July 2009

THIS YEAR, THE TRAINEES and supervisors from the South West Region met in Salisbury (figure 1) to share experiences and improve their own training schemes by determining the ‘best practices’ across the region.

MORNING SESSION
An early start for most called for some strong coffee and a general catch up between the various mentors and supervisors. There was a strong turnout from all centres which leant for a friendly atmosphere. Following a warm
welcome from organiser Tom Lister, Paul White (Chairman of the IPEM Accreditation and Training Committee) started things off with an introduction and overview to all parts of the training scheme. After an extensive amount of questions from trainees and mentors alike it was time to move on to the scientific presentations from Part I trainees.

Francis Gibbons (Gloucestershire Hospitals NHS Foundation Trust, Cheltenham) opened the presentations with a critical analysis on the use of ‘MOSFET detectors for in vivo patient dosimetry’, a project undertaken by Francis during his Part I training placement in radiotherapy. Ruth Ruddlesden (current second year Part I trainee, Bristol) followed Francis with an in-depth overview to all parts of the training scheme. After an extensive amount of questions from trainees and supervisors/mentors, with the aim of discussing three pertinent topics. Afterwards, the groups reconvened to share their conclusions and discuss the topics further, chaired by Duncan Wood (Salisbury co-ordinator). The following is a summary of this discussion.

Managing portfolios
The discussion was focused on Part I portfolios and highlighted pressures on trainees with regard to this.

It was decided unanimously that the majority of portfolio writing should be done within working hours. The general feeling was that this should be supported with protected time for portfolio writing during the placements and at the end of the three placements. It was suggested that the time should be flexible to fit in with the nature of training opportunities, which may arise at any time or day of the week. The proportion of time to be protected for portfolio writing was discussed, with suggestions ranging from 20 per cent to 50 per cent.

The general structure of the portfolio was discussed. It was felt that the current format often contained too much textbook material. It was commented that this reflects the format of the viva voce examinations. Delegates felt that the Part I portfolio structure would benefit from being more like a series of reports. In contrast, people were happy with the structure of the Part II portfolios.

There was a general consensus that more should be done to encourage Part I trainees to write up their portfolios throughout the placements, rather than leaving much of the work until the end. Suggestions were made to achieve this, including a performance appraisal at the end of each of the three placements. This would perhaps require an assessment of portfolio standard to decide whether or not to transfer the trainee from the current placement to the next. Also, trainees and supervisors felt that a mock viva after the first placement would be helpful for assessing the quality of the portfolio. This would be in addition to the current mock viva format in the South West region.

Written feedback from the day suggested that centres may look for a more structured approach to the Part I training they provide, in particular with the management of portfolios.

Contrasts between Part I and Part II training
Delegates felt that Part I trainees are more limited in what they can do, although this was appropriate due to the experience of the trainees. It was mentioned that there is a large gap between Part I and Part II training, with Part I’s following a relatively strict curriculum and Part II’s having much more flexibility, with much less guidance.

It was mentioned that the clarity of supervisory roles was greater for Part I trainees. Delegates discussed the role of mentors for Part II trainees and supervisors. They felt that mentors can be useful but it is important to find the right person. Trainees have External Training Advisors who can take a similar role to mentors, although it seems they are not used very much.

We discussed the six monthly reports for Part II trainees and delegates felt that they could benefit by combining these short reports with their trust appraisal scheme.

Managing extra-curricular activities
When discussing attendance of meetings and performing presentations, delegates felt that this should not be thought of as ‘extra’ curricular but is instead essential to the training. Furthermore, delegates felt that trainees would benefit from making more of the meetings held within the South West region.

There was a very positive feel about the prospect of getting involved with the community, in particular with school science days. Also, delegates discussed the benefits of seeing other departments. It was mentioned that Special Interest Groups were useful to join but it is difficult to get accepted into one. The group concluded that networking, both within the hospital and further afield, was a critical part of the training scheme.

Other points
The MSc courses in Surrey were discussed. Differing opinions were viewed on the advantages and disadvantages of having a broad curriculum. It was
A RADIOTHERAPY LEARNING EXPERIENCE: 
9TH MAYNEORD–PHILLIPS SUMMER SCHOOL

EVA RUTKOWSKA University of Liverpool
MEKALA CHANDRASEKARAN Clatterbridge Centre for Oncology

ST EDMUND’S HALL, UNIVERSITY OF OXFORD 6th–10th July 2009

THE MAYNEORD–PHILLIPS SUMMER SCHOOL is a biennial residential course designed to accommodate a small group of PhD students and medical physics researchers early in their career. This year’s school, the first to focus on radiotherapy, was entitled ‘21st Century Radiotherapy: State-of-the-art and Predicting the Future’ (see figure 1).

HIGHLIGHTS FROM DAYS 1 AND 2
The meeting began with a welcome and overview given by Colin Baker (University of Liverpool), the organiser of this year’s meeting. Next up was Steve Webb (Institute of Cancer Research, Royal Marsden NHS Foundation Trust, Sutton), who outlined the evolution of intensity-modulated radiation therapy and pointed out challenges encountered in radiotherapy that need to be addressed in the near future.

Two of these challenges, organ motion and target delineation, were discussed in detail later in the day, the former by Dan Low (Washington University School of Medicine, St Louis, MO, USA) who looked at 4D CT, and the latter by Marcel van Herk (Netherlands Cancer Institute, Amsterdam, The Netherlands) who concentrated on different imaging modalities, image registration and fusion.

Lectures on the second day focused largely on radiobiology, which kicked off with a talk on classical radiobiology from John Fenwick (Clatterbridge Centre for Oncology, Wirral) and followed by Bleddyn Jones (University of Oxford), who examined radiobiology for neutrons, protons and light ions.

Afternoon sessions examined radiobiological modelling, currently a captivating research issue. Tumour control probability models were reviewed by Marco Carlone (University of Toronto, Canada) and normal tissue complication probability models by John Fenwick. Catherine West (University of Manchester) pointed out the necessity to change the radiobiological modelling framework to include the influence of chemotherapy on local tumour control.

On a different note, Alan McKenzie (Bristol Oncology Centre) presented practical principles for cost-benefit management of resources in the radiotherapy department, with a judgment grown from much experience.

KNOWLEDGE UPDATE
The third and fourth days covered a wide range of stimulating topics. Marcel van Herk intriguingly illustrated the necessity to manage errors in radiotherapy – both due to set-up inaccuracies and organ motion – in order to ensure tumour coverage and sparing of critical structures. He also presented possible solutions; for example, treatment planning on a CT series with the tumour in an average position over the breathing cycle, chosen from a 4D scan.

Similarly, Rock Mackie (University of Wisconsin, Madison, WI, USA; TomoTherapy, Madison; figure 2) emphasised the importance of image guidance for conformal treatments and explained the techniques of tomotherapy. Mackie also presented details of a dielectric wall accelerator for proton therapy, which he and his colleagues are currently developing.

Those who thought boron neutron capture therapy (BNCT) a thing of the past learned differently when Stuart Green (University of Birmingham) presented new developments in this area. Green argued that BNCT is a modality that can bridge the visibility gap between chemotherapy and radiotherapy when it comes to locally-spread disease.

NOTE FROM TOM LISTER (PART II TRAINEE, SALISBURY DISTRICT HOSPITAL; ORGANISER)
Written feedback was very positive and the organisers would like to thank those who were able to attend the day. I would especially like to thank Dr Paul White for his fantastic talk and interest in the day, and Dr Duncan Wood for help with the overall organisation and for running the afternoon session. I would also like to thank Dr Mohamed Mirghany and Mr Dominic Nolan for their involvement in organising all aspects of the day and Dr Francis Gibbons for his help with the morning session.

mentioned that the physics course has undergone many changes in the last 2 years, the most recent changes of which were beneficial (although further improvement would be encouraged). In contrast, recent changes to the engineering course were perceived as detrimental. Delegates also mentioned recent (minor) organisational issues on the physics course.

All in all this proved to be a very worthy session with many lengthy discussions concerning the most efficient way to manage the training experience and many new outlooks gained on the training process.

To summarise, the trainee bonding day was designed to give new Part I trainees insight into the training pathway, share training practices from centre to centre as well as sharing experiences between trainees (i.e. start writing your portfolio NOW!). On this basis I think it proved to be a huge success. I know personally that I gained a lot from this experience and would like to thank Tom Lister and Dr Duncan Wood at Salisbury for their warm hospitality and smooth organisation.

I would like to thank those who were able to attend the day. I would especially like to thank Dr Paul White for his fantastic talk and interest in the day, and Dr Duncan Wood for help with the overall organisation and for running the afternoon session. I would also like to thank Dr Mohamed Mirghany and Mr Dominic Nolan for their involvement in organising all aspects of the day and Dr Francis Gibbons for his help with the morning session.

In summary, the trainee bonding day was a very worthy session with many lengthy discussions concerning the most efficient way to manage the training experience and many new outlooks gained on the training process.
A taste of the future was provided by Rob Edgecock (Particle Physics Department, Rutherford Appleton Laboratory, Didcot) who talked about the fixed field alternating gradient accelerator, and David Neely (Central Laser Facility, Rutherford Appleton Laboratory) who discussed laser plasma-based accelerators that could be used to accelerate many different kinds of particles and deliver extremely high dose rates.

On the concluding day of the school, Glenn Flux (Institute of Cancer Research, Royal Marsden NHS Foundation Trust, Sutton) provided an update on developments of dosimetry for radionuclide therapy. Markus Alber (University Clinic for Radiooncology, Tübingen, Germany) then spoke about physical and biological optimisation and presented a recipe for quantifying intuitive dose–volume constraints for normal tissues. The influence of temporal modulation on treatment outcome was considered by John Fenwick, who is using delay differential equations to model the development of early complications during radiotherapy.

The summer school ended as it started, with a captivating lecture from Steve Webb, this time focusing on the likely areas in which radiotherapy will develop in the future.

HIGHLY RECOMMENDED
The Mayneord–Phillips summer school delivered exactly what it promised: lectures encompassing the full range of radiotherapy, presented at just the right depth and which enabled the students to visualise their research in a wider perspective, as well as gain greater understanding in related areas.

The involved discussions that followed each lecture were only too short, with most lecturers struggling to fit what they wanted to say within their allocated time slot. However, most of the faculty stayed at the college for the full week, providing a great opportunity for the students to converse with them and gain feedback on their own research.

The school also included tutorial sessions, in which students were given the opportunity to present on their areas of research and receive feedback from other students and the teaching faculty.

Inspiring lectures, discussions and the opportunity to meet other researchers are a great motivation as a contrast to the often lonely every-day life of the PhD student (figure 3). As such, the next summer school in two years’ time is highly recommended to all.

The full programme from the 2009 Summer School, including links to most of the presentations, is available on the Mayneord–Phillips Trust website at www.m-pss.org. Details of previous Summer Schools can also be found on the Mayneord–Phillips Trust site.

ABOUT THE AUTHORS
Eva Rutkowska and Mekala Chandrasekaran are PhD students in radiotherapy physics at the University of Liverpool and Clatterbridge Centre for Oncology.
FIGURE 2.
Networking opportunity with Rock Mackie (second from right).

FIGURE 3.
Drinks reception at St Edmunds Hall.
The purpose of this study day was to review the theoretical background and practical implementation of the Radiotherapy Dosimetry Codes of Practice (CoP). The CoP recommends procedures both for measuring radiation output from a linac or 60Co unit, and also for calibrating field instruments using a secondary standard calibrated by the National Physical Laboratory (NPL).

Hugo Palman (NPL) began the day with a useful refresher on the theory, equations and symbols used in dosimetry. Subsequent talks alternated and contrasted the perspectives of members of the NPL calibration service with those of clinical physicists responsible for implementing kV photons, MV photons, electrons and HDR brachytherapy in UK oncology departments.

Perhaps reflecting the dominant frequency of clinical usage, one of the key presentations was ‘MV photon dosimetry in the clinic’ by Andrew Williams (Norfolk & Norwich University Hospital NHS Trust, Norwich). In his talk, he said the CoP tells us how and what to do, but not who should do the calibration (figure 1), the level of experience required, when to do it or even to double-check the results. He said the CoP does not even tell us to write down all the measurements! Guidance on these matters is instead contained in IPEM 81. Dr Williams continued his witty presentation with important considerations and practical tips for performing MV dose measurements.

Russell Thomas (NPL) gave a very pragmatic talk on the important topic ‘Maintenance of secondary standard and field instruments’. Delivered in his own inimitable style, Russ began with the provocative declaration: This is without doubt the most important lecture that you will be given during this course... you may be the best physicist in the world but if the equipment you are using does not work correctly then any measurements that you make will be worthless.

Based on years of work with the NPL calibration service, his talk could have been sub-titled ‘Look after your equipment and your equipment will look after you’, and featured many photographs, radiographs and stories of what happens if you don’t (figure 2).

We all know that our measurement chambers and dosemeters are crucial pieces of kit; expensive to purchase, calibrate and commission, and fundamental to the QA chain in every radiotherapy department. Yet Russ shared many horror stories of equipment negligence witnessed during hospital visits.

Russ even had a scare story for those of us who treat our equipment with paranoid reverence: ‘don’t forget your phantom’. He said that although PFI contracts guarantee a dust-free environment during building work,
any dust that does escape (heaven forbid) will settle on every exposed surface. This includes any solid phantoms left on a shelf and hence into the chamber insertion holes. From there dust can enter the chamber’s vent hole and impair function and reliability.

Mark Bailey (NPL) delivered an interesting presentation on ‘Electron dosimetry at NPL’, referring to the advances made in the 2003 CoP compared to the 1996 code. In his talk, he discussed some of the subtleties and complications of electron dosimetry. Near the end of his talk, Mark asked the audience which code they used in their clinic. Only about two-thirds have adopted the 2003 code with about one-third still using the 1996 code. Surprisingly, one centre is still using previous guidance, which stunned the speaker and the audience.

In summary, more than 70 delegates from all over the UK attended this very informative meeting. Alternating talks between the NPL staff and clinical physicists for each modality was a very useful structure. Many in-depth discussions ensued during the breaks between the speakers and audience members. Armed with a deeper understanding of the codes, now is the time to practice.

**FIGURE 2.** Equipment negligence.
followed by a keynote lecture from Derek Gould (Royal Liverpool University Hospital). Later on the same day, an eponymous lecture was sponsored by the Hospital Physicists Association and the speaker was Surgeon Rear Admiral Lionel Jarvis (Ministry of Defence) who talked about globalisation and delivering medical care in the battle field. The Institute’s Woolmer memorial lecture was in the afternoon on day 1 and the speaker was Martin Birchall (University College London), a leading ENT surgeon, who talked about new challenges and new hopes in regenerative medicine.

The Institute of Physics organised a small meeting within this conference on novel imaging detectors with five keynote lectures and six proffered papers. In a new departure for the Institute, a public session organised by Sense about Science took place on day 2 (figures 3–5). The topic was full-body MRI scanning. Speakers included Stephen Keevil (Guy’s and St Thomas’ NHS Foundation Trust, London), Laura Parkes (University of Manchester), Michael Fitzpatrick (a GP from Hackney, London) and Peter Mace (BUPA Wellness), and was followed by a panel debate with questions.

A number of teaching sessions were organised including a scientific computing session on day 2 organised by the Informatics and Computing Special Interest Group, and a leadership session on day 3 which was addressed by Sue Hill (Chief Scientific Officer, Department of Health, London) and other leading figures. Also on day 3 was a special session on registration and CPD matters and speakers included Iain Chambers (James Cook University Hospital, Middlesbrough), myself and Justin McCarthy (ClinEng Consulting Ltd, Cardiff).

Personally, I found the whole experience of hosting this event extremely enjoyable and worthwhile, although it was hard work at times and not without some last minutes hiccups which (hopefully) went unnoticed. I would like to express my sincere thanks to the support from the IPEM office personnel and members of the Science Board and organising committee who helped with the programme.

Here are some reports from delegates and session organisers related to sessions that they attended.

**MICHAEL LYNN (FORMER UNIR SIG CHAIR, ROYAL BERKSHIRE NHS FT, READING)**

I was fortunate to be able to attend all 3 days of the conference. I expected it to be a great opportunity for networking (which it was) and hopefully to attend interesting scientific presentations. The opening speech on the first morning set the scene with a thought-provoking address by the Dean of Liverpool, the host city. The Very Reverend Justin Welby described his work in Africa before taking up his present incumbency and encouraged us to apply our efforts in physics and engineering for the greater good. The Woolmer Lecture continued this theme with practical examples from regenerative medicine, presented by Martin Birchall. The scientific sessions then got under way. I had the pleasure to jointly chair two of these sessions, in ‘Optical measurement’ and ‘Regulations and guidelines’, both of which were very well attended. The audience for ‘Optical measurement’ was firstly given a review of photoplethysmography by John Allen (Freeman Hospital, Newcastle upon Tyne) which helped our understanding of subsequent papers involving this technique. Other optical topics included the metrology of optical coherence tomography and a new use for Raman spectroscopy which holds promise to solve the technical problems encountered in endoscopic surveillance of the oesophagus. ‘Regulations and guidelines’ might be thought of as rather a dry topic but it was brought to life by our speakers. Tim Beaumont (Health and Safety Executive (HSE), Bootle) gave an overview of how the HSE develops its policies and guidance, especially with reference to the EMF and Optical Radiation Directives which are due to be introduced in the UK. The next two papers dealt with surveys of occupational exposure to the radiations referred to in these directives.

Once my chairing duties were finished I could relax and appreciate the ‘wider dimension’, vividly illustrated in the eponymous lecture delivered by Surgeon Rear Admiral Lionel Jarvis entitled ‘The global use of medical devices in military scenarios’. I hardly expected someone from the Assistant Chief of Defence Staff to say much about the technical aspects of these devices but he had a very well illustrated slide show demonstrating the surprising extent to which the world’s population is concentrated in coastal areas and what might happen to this population if current meteorological trends continue. Social and political instability are obvious military concerns. Switching from possible scenarios to the present day, we were shown slides of the field hospitals in Afghanistan and I was impressed by how well organised it seemed and struck by how little we see of this in the press or on TV.

Other presentations which I enjoyed were about survivorship in cancer and a public session on MRI. Survivorship is concerned with ‘Living with, or beyond, cancer’ according to Nicola Cook (Macmillan Cancer Support, London), who explained how this affects the two million people in the UK currently living with cancer and the financial and emotional issues they face. Originally Macmillan was associated with palliative care but now wishes its 4,000 professionals (50 per cent nurses, 50 per cent therapists etc.) to be better known for their supportive work.

The public session sponsored by Sense about Science was a new venture for IPEM. There were three presentations on MRI followed by a panel discussion and debate. The principles of MRI and the importance of functional MRI were explained at the right level for a public session, appropriately illustrated with slides. This was followed by a personal view from Michael Fitzpatrick, a GP from Hackney, who also contributes to medical journals. He spoke fluently, eloquently and entertainingly without slides, only pausing when he made the best (entirely unintentional!) joke of the conference. He had been in full flow about the demand for screening for all sorts of conditions when he declared: ‘It now seems to me that screening for prostate cancer is being introduced by the back door’. When his audience recovered he carried on unabashed. It was a really impressive performance.

Another innovation was the three sessions on ‘Leadership and innovation’ with views from within and outside of the NHS. Some had heard it all before but I think the majority of attendees benefited.

I look forward to MPEC 2010.
FIGURE 1. [TOP LEFT] Dr Diane Crawford at the AGM.

FIGURE 2. [TOP RIGHT] Dr Chris Gibson’s first address as an IPEM President during the AGM.

FIGURE 3. [MIDDLE LEFT] Dr Michael Fitzpatrick, GP, at the public session.

FIGURE 4. [MIDDLE RIGHT] Dr Peter Mace, BUPA, at the public session.

FIGURE 5. The public session panel. From left to right: Dr Peter Mace, Dr Laura Parkes, Dr Stephen Keevil and Dr Michael Fitzpatrick.
**leadership and innovation sessions: steve lake (royal liverpool university hospital)**

The leadership sessions were opened by Keith Ison who invited Sue Hill to give the first keynote lecture. Professor Hill discussed the QIPP (quality, innovation, productivity and prevention) agenda and set out the importance of physical sciences to the future of healthcare. Clinical leadership was discussed along with how managerial and clinical priorities need to be addressed. The responses received to Modernising Scientific Careers were discussed including how disappointing it was to find that the patient was mentioned so little. It was noted that a great many of the responses had been inwardly focused on departmental staffing rather than outwardly on how departments ’fit in’ with the rest of healthcare.

The next keynote speaker was Beverly Alimo-Metcalfe (Bradford University School of Management, Bradford) who gave a lively talk on what transformational leadership is about and why it is needed. Gone are the days of ‘Rambo in pinstripes’ and incoming are requirements to invest in staff. Professor Alimo-Metcalfe states how the private sector is better at the ‘soft stuff’ but notes we are a caring profession. We should be better at celebrating our achievements. Job satisfaction can lead to motivation, commitment and then ‘engagement’ which are described as the new targets for transformational leaders. Are the new competency frameworks relevant to the NHS of tomorrow? Professor Alimo-Metcalfe presented results from the largest leadership survey carried out in the NHS and discussed the links between leadership, effectiveness and wellbeing.

The second leadership session was chaired by Liz Dymond (North Bristol NHS Trust, Bristol) who invited Geoff Meads (University of Warwick, Coventry) to give a keynote lecture on ‘Inter-professional collaboration’. Professor Meads discussed the various relationships formed during work within our profession, with other professionals, government, the public and the patient. How the understanding of participation had changed in the new NHS to become more collaborative was explained. A revealing exercise was carried out by surveying what kind of team members of the audience perceived they operated in, drawing on models from the sporting world of cricket, soccer, tennis, rugby and basketball. Professor Meads discussed how working in teams gave a ‘collaborative advantage’ along with examples of where this had significantly improved performance. We were finally left with the advice that going solo is no longer an option, being interprofessional is being professional, engaging in policy development, negotiating a shared learning approach in the public interest and trading for real reciprocal patient exchange.

The final leadership session was chaired by Steve Lake (Royal Liverpool University Hospital) who invited Alastair Mitchell-Baker (Tricordant Ltd, Worcester) to give a keynote lecture on ‘Innovation in the NHS’. Alastair focused his talk on the adoption stage of the innovation life-cycle. The myriad of organisations involved in supporting innovation were explored along with the need for a map to guide which to use and when. Alastair concluded by looking at the barriers to adoption and how organisations can increase their capacity to adopt. He discussed how knowledge plays an important part in disseminating and adopting innovation and made recommendations on what Trusts can do to take advantage of innovation in the future.

**john pickett (former pmsig chair)**

The session on optical measurements kicked off with a comprehensive review of the clinical applications of photoplethysmography from John Allen. Following on from this, he went on to describe work investigating the use of photoplethysmography to assess coronary heart disease by examining the reactive hyperaemia response. The third presentation, from Jonathan Ashmore (Barts and The London NHS Trust, London), addressed the use of continuous arteriovenous oximetry to examine the reactive hyperaemia response in patients undergoing cardiopulmonary bypass surgery. Catherine Kendall (Gloucestershire Hospitals NHS Foundation Trust, Gloucester) outlined the development and assessment of a new Raman probe for use in endoscopic assessment of oesophageal disease. This in vitro work demonstrated the potential of the system to acquire useful spectra in a clinically practical timeframe. Peter Tomlins (National Physical Laboratory, Teddington) then described the development of test phantoms to determine the sensitivity, resolution and contrast of optical coherence tomography instruments, before Michelle Hickey (City University, London) presented preliminary measurements using a new fibre-optic sensor to collect photoplethysmographic signals from human splanchnic organs.

Ian McCarthy (Royal National Orthopaedic Hospital, Stanmore) opened the physiological measurement session, describing the measurement of regenerate bone stiffness in distraction osteogenesis of the tibia. Two presentations from City University, London, then followed; Shafique Muhammad on the design of a new trans-reflectance photoplethysmograph probe and Kamran Shafqat on wavelet analysis of heart rate variability. David Simpson (University of Southampton) described a novel test for the detection of auditory brainstem evoked potentials, with the potential for reducing the number of stimulations required to detect the evoked potential and hence reduce the examination time. The clinical evaluation of a new subcutaneous cardioverter defibrillator was the subject of the next presentation, from Stephen O’Connor (Cameron Health, San Clemente, CA, USA), and the session was rounded off by a paper from Hazel Boyd (Bath Institute of Medical Engineering, Bath) detailing a potential assessment technique for identifying elderly people at risk of suffering falls.

**apen sessions and activities**

Rosemary Eaton (Guy’s & St Thomas’ Hospitals, London)
Sarah Higgins (University Hospitals Coventry and Warwickshire, Coventry)
Nicola Kent (Newcastle General Hospital, Newcastle)
Alan McWilliam (Christie Hospital, Manchester)

The aim of the three ‘trainee sessions’ was to provide a forum for trainees to present work carried out during their placements or MSc to an audience of peers, in a friendly and non-threatening environment. All of the talks were of a high standard, in both quality of research and quality of presentation.
The first trainee session covered various topics in engineering and MRI. Talks of particular note include a description of measurements of fat and muscle volumes by MRI in the legs of ambulant spastic cerebral palsy sufferers from Andrew Lewis (King’s College Hospital [KCH], London). The realisation that patients may have high levels of fat could lead to changes in physiotherapy treatment. Robert Batty (Salisbury District Hospital) described a technique for deducing foot orientation by using data collected by a force-measuring device in the shoe. This has applications for those suffering from drop foot, where data could be fed back to control a functional electrical simulation device. In the final talk of the session Stephen Wastling (KCH) described the need to rotate the b-matrix during the reconstruction of diffusion tensor MRI images, if there has been significant movement of the head during scanning.

All presentations in the second session were about projects carried out as part of radiotherapy training placements. The topics covered included the development of planning techniques for the breast (Justine Calvert (KCH)) and the lung (Carolyn Furlong (Royal Liverpool University Hospital)). There were three talks on brachytherapy: optimising the fractionation schedule of an HDR brachytherapy treatment using radiobiological modelling (Tracey Underwood (KCH)); commissioning a 3D image-guided brachytherapy procedure (Joanna Barraclough (Addenbrooke’s Hospital, Cambridge)), and the dosimetric analysis of prostate J-125 brachytherapy plans which resulted in urethral strictures (James Earley (Royal Surrey County Hospital, Guildford)). There was just one talk on radiotherapy equipment by Alan McWilliam (Christie NHS Foundation Trust, Manchester) which described a project looking at optimising MLC calibration to ensure the accuracy of head and neck IMRT delivery. A more unusual project on the effect of irradiation on bovine pericardium tissue was presented by Elaine Woods (Royal Free Hampstead NHS Trust, London). A scanning electron microscope was used to look at the nano-structure, and mechanical testing was also carried out.

The first half of the final session was focused on nuclear medicine, with talks describing left ventricular ejection fraction in PET/CT (Matthew Gray (University College Hospital, London)) and comparison of SPECT/CT reconstruction techniques (Jennifer Gregson (Royal Liverpool University Hospital)). An interesting talk by Bruno Rojas Fisher (University College Hospital) on small angle x-ray scattering system for characterising various samples bridged the gap to a selection of magnetic resonance imaging presentations. The session was finished with a complete change of subject with a radiotherapy talk by Rachel Hollingdale (Guy’s and St Thomas’ NHS Foundation Trust, London) comparing ionisation chambers and TLDs for measuring small field output factors. These talks sparked probing questions from the audience with debates that promised to continue after the session had finished.

The wide variety of presentations in the trainee sessions highlights the true breadth of our field. No other sessions had this diversity and this is where the real strength of the trainee sessions lies. The sessions also showcased the fantastic work that trainees are involved in and the contribution that they make to the subject. For example, it is often the trainees within a department that have opportunity to carry out much-needed development work to commission new techniques and equipment. There was a particularly enthusiastic and supportive audience at all three sessions, who were keen to hear what trainees in their own and other centres had been doing.

There were many stalls to visit at the MPEC, including one run by the Associate Physicists and Engineers Network (APEN). The APEN stall provided trainees with a chance to meet some of the APEN panel, and ask them any questions they had about the training scheme. There were also sample portfolios from previous trainees to browse through. These proved to be particularly popular, as they demonstrated the typical layout and content of a portfolio and provided reassurance to a number of tense trainees.

On Monday evening the APEN panel invited all trainees to join them at La Tasca for a tapas meal. There was an amazing turnout, as 80 people descended on the restaurant to enjoy a night of Spanish food and a glass of wine (or two!). It was a great opportunity to meet other trainees, and relax after a long day of talks.
THE INTERNATIONAL CONTINENCE SOCIETY (ICS) is an international membership society for medical professionals concerned with furthering education, scientific research, clinical practice and removing the stigma of incontinence. Each year, their annual conference brings together eminent professionals from a variety of backgrounds, both medical and scientific, to discuss key issues regarding both urinary and faecal disorders and how to improve and sustain patients’ care and quality of life. I am currently coming towards the end of a PhD in bladder contractility within Freeman Hospital Medical Physics department. This year, being my last, I submitted two abstracts which were accepted as a discussion poster (poster display plus short presentation) and a non-discussion poster.

I was lucky enough to be granted an IPEM travel award which allowed me to jet off to the much sunnier climes of San Francisco in late September (figure 1). I was thrilled to hear that this time of year had the lowest chance of fog and was therefore able to take numerous photos of the fabled Golden Gate Bridge (figure 2). These, in my humble opinion, much outdid the rather gloomy image that adorned the lecterns in front of many speakers at the meeting! The week consisted of 2 days of educational courses and workshops and 3 days for the scientific programme – in total 284 presentations from centres around the world. The topics ranged from pregnancy and childbirth to basic pharmacology and from quality of life to neurourology, in as many as four concurrent sessions.

My first task, after overcoming jet-lag and finding the correct building in the sprawling Moscone Center, was to be chief note-taker in the workshop entitled ‘Urodynamic equipment – limitations and challenges’, hosted by Andrew Gammie (Bristol Urological Institute). The webcast of this session, along with many others, is available at http://webcasts.prous.com/ICS2009. The aim of this gathering was to bring together clinicians, researchers and manufacturers to provoke discussion on the shortcomings and requirements of urodynamic equipment, and the need for guidelines and standards. The range of people attending the meeting made for interesting discussion and highlighted the differing opinions of clinicians, manufacturers and researchers, and...
FIGURE 2. The Golden Gate Bridge.

FIGURE 3. City Hall.
also the fundamental differences between healthcare systems. Most were in agreement that there should be standards and guidelines in place for urodynamic equipment and tests, but the main issues are who will implement them and how they will be enforced. Currently, only when these are enforced will this market pull encourage manufacturers to comply, so it is important to ensure all parties have a say. The financial aspect of imposing these standards also provoked debate, with particular reference to the US healthcare system, but with increasing relevance to the system in the UK. Despite the equipment focus of the workshop, it was evident that one of the main issues is standardisation of training of those carrying out urodynamics.

After the workshops and educational courses had finished, a welcome reception was held to mark the beginning of the meeting proper. It was held in the regal San Francisco City Hall (reminiscent of 17th-century French architecture yet built in 1915, figure 3) with a range of buffet contents chosen to represent the city’s inhabitants. Although the sushi appeared to be approached with some caution, the wine was enjoyed by most, and the event proved a good opportunity to make new contacts and catch up with older ones.

The scientific programme kicked off the following day, back at Moscone West, with the opening ceremony. The main hall consisted of a display of just shy of 600 posters to keep us occupied during coffee breaks, along with a number of stalls from equipment manufacturers and pharmaceutical companies showcasing their wares and playing rather graphic videos of surgical techniques to unsuspecting lunchers! Unfortunately, as no tables or chairs were provided in the venue, except in meeting rooms, the main hall was not the flurry of discussion, chatting and networking that it has been in the past. Among the sea of landscape A0s was my non-discussion poster (figure 4), which tested Derek Griffiths’ (University of Pittsburgh, PA, USA) theoretical bladder models using a penile cuff to gradually reduce flow. Unfortunately, it did not attract the attention of the man himself – he was unable to make it – but I was sought out by one reader for discussion, and so I presumed that there must have been many more who had similarly enjoyed the read!

A number of ‘state of the art’ lectures peppered the conference, with guest speakers invited to give 30 minute talks on topics judged to be ‘à la mode’. The first was an interesting update on imaging and modelling of the pelvic floor by John DeLancey (University of Michigan, MI, USA). He spoke about methods to determine the structural deficiency in the pelvic floor which cause prolapse, and presented a 3D finite element model of the anterior vaginal wall, and the addition of other structures to model and simulate prolapse under increasing abdominal pressure. This aids identification of the cause of pelvic organ prolapse. A lecture by Jack Winters (New Orleans, USA) picked up on the hot topic from the workshop I had attended, describing education and training of urodynamics studies. He too supported comprehensive training, and suggested using a standardised, interactive multimedia course, and subsequent proficiency testing of those carrying out urodynamic tests. How this training and standardisation may be implemented was not discussed. Kate Lloyd

**FIGURE 4.** Experimental and theoretical bladder output relation.
FIGURE 5.  
My presentation.

FIGURE 6.  
The first method of continuous and non-invasive bladder pressure measurement.

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Hypothesis

We can use an inflatable penile cuff to measure bladder pressure non-invasively and continuously by keeping it inflated at 2.5 m/s.

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The first method of continuous and non-invasive bladder pressure measurement

Clarkson B*, Robison WP, McAlindon P, Griffiths G, Pickard R*, Dimman MP

Introduction

Continuous bladder pressure measurements can be made non-invasively. Alternatively, non-invasive and measurements can be made (e.g., penile cuff, condom catheter). We have developed a technique which can measure bladder pressure continuously and non-invasively throughout a test. We hypothesise that keeping few series at a constant rate, less volume in the penile cuff, to measure the pressure in the cuff should approximate to the bladder pressure.

Method

40 patients having invasive PFS were asked to perform a controlled free flow test with simultaneous invasive (urethral pressure measurement). A penile cuff was inflated and bladder pressure was measured for 1 minute. The cuff pressure and PFS were then compared for accuracy.

Results

1. A patient gave good results (inflated cuff at 0 and 2.5 m/s; a pressure of 10% above baseline)
2. A patient showed a consistent offset between PFS and cuff pressure
3. A patient was not affected by the technique measurements
4. The technique showed some variability in obtaining results

Conclusions

The cuff can accurately measure bladder pressures when flow is kept at a low rate.

Further Work

Study of penile pressure with CUF and non-invasive abdomen hydrostatic level.

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*Author on behalf of Newcastle University Department of Urology.
(pharmaceutical consultant, UK) raised a number of interesting points about the relationship between healthcare professionals and the pharmaceutical industry, specifically with regard to education. She discussed the impact of the RCP working party suggestion to wean doctors off training support from the pharmaceutical industry, and its effect on industry funding. Her interactive show of delegates attending with no influence from pharmaceutical funding was interesting – those left standing were few! She described the mistrust of industry’s influence, and predicted that change would be a slow process but the relationship would eventually become more productive.

I mostly attended the sessions with presentations in neurourology, gerontology and benign prostatic hypertrophy, as this is where my interests lie. The neurourology sessions included stressing of rats to assess changes in bladder behaviour, pudendal versus sacral nerve stimulation, the effect of botox on neurogenic detrusor overactivity and the effect of prostate size on urodynamic results. The prize for best clinical abstract was split between two in the neurourology category, using functional MRI studies to map the brain responses to bladder filling in women with urinary retention and in patients with urge urinary incontinence. Both were interesting, well presented and provoked some discussion in the meeting hall. The poster presentation sessions were somewhat frenzied, with 2-minute speeches which inevitably overran, and 3-minute question slots which sometimes culminated in a battle of wills between the chairperson and the questioner. However, the nature of the presentations allowed the listener to gain an overview of a number of different research projects without being lost in the fine detail, and thus these sessions were ideal for delegates sampling a slightly foreign subject, as is often the case in these sessions. Any discussions of interest could easily be revived after the session.

By far the most nerve racking was the last session: urodynamic techniques and bladder outlet obstruction. Chaired by Werner Schaefer (University of Pittsburgh), and at the last minute Clive Griffiths (Newcastle University), this was to be the stage for my 2 whole minutes of fame, the culmination of my 3 years of PhD work (figure 5). I took my post (figure 6) and answered some initial questions before the session began, then sat nervously on the front row to wait my turn. I barely had time to draw breath before my 5 minutes on the podium was over! The audience had been kind, projecting interest and asking good, but not difficult, questions.

I had presented what I billed as ‘The first method of continuously and non-invasively measuring bladder pressure’. As part of my PhD work I have been testing a new device which uses an inflatable penile cuff in men to restrict urine flow to a constant low rate. At this meeting I presented the practical work I had done to support our hypothesis that, when controlling the pressure in the cuff to keep the flow at a constant rate, the pressure in the cuff should be equal to the pressure in the bladder, thus being a measurement of bladder pressure. By performing this technique on men who were having simultaneous invasive bladder pressure measurements made, this hypothesis could be tested. An example is shown (figure 7) with cuff pressure in red, following the invasively measured vesical pressure in blue. The corresponding flow trace is shown in green and the root mean square difference between the two measurements during controlled flow was less than 5cmH2O. I found that in a number of men this technique worked extremely well, and used the initial study to suggest ways that the technique could be improved. The
work was received well and I got some encouraging comments after the session.

I left the lecture hall and breathed a sigh of relief. I walked out of the Moscone Center and hit the road, poster tube in hand (Bazooka? Tube of Smarties? It seems airport security has gained a sense of humour!), to explore the delights of southern California (figure 8).

I’d like to thank IPEM for giving me the chance to travel to this immensely useful conference. I’d also like to thank my supervisory team: Clive Griffiths, Rob Pickard, Michael Drinnan and Frank McArdle for their support and encouragement, and Wendy Robson for the hours she’s spent helping me get my data, without which there would be no poster or presentation!

**FIGURE 8.** Big Sur, the southern Californian coast.

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**48TH PARTICLE THERAPY CO-OPERATIVE GROUP MEETING**

**DANIEL KIRBY** Medical Physics, University of Birmingham

THE END OF SEPTEMBER saw the 48th meeting of the Particle Therapy Co-Operative Group (PTCOG), in the historical university town of Heidelberg, Germany (figure 1). This year’s meeting drew around 700 medical physicists, oncologists, students and researchers and the rapid growth of its members mirrors that of the ion beam therapy (IBT) modality itself. The congress was split into a 2½-day educational session and a 3-day scientific session, and included a welcome party, conference meal at Heidelberg Castle and a tour of the new Heidelberg Ion Therapy (HIT) centre in all of its 600-ton, ion gantry splendour. I felt honoured to be accepted for a poster presentation, and was fortunate to receive a bursary award from IPEM to help fund my attendance.

**EDUCATIONAL SESSION (PHYSICS/BIOLOGY)**

The session was structured with physics and biology talks in the mornings and clinical talks in the afternoons. Marco Schippers (Paul Scherrer Institut, Switzerland) and Thomas Habeer (HIT, Germany) presented the relative merits and limitations of using cyclotrons or synchrotrons for producing a clinical ion beam. Cyclotrons offer a smaller footprint and a continuous, fixed-energy beam which has to be degraded mechanically, while synchrotrons can vary energy between ‘spills’ to give the exact penetration required, but the beam is highly pulsed. Markus Roth (GSI, Darmstadt, Germany) then described new accelerator concepts like the dielectric wall accelerator, and in more detail the idea of laser-plasma acceleration, which is in the relatively early stages of investigation by many (highly competitive!) research groups around the world. I found this particularly of interest, as my PhD research is part of the UK laser-ion research consortium Laser Induced Beams of Radiation and their Applications (LIBRA) and it was interesting to see how other groups were progressing.

Tuesday morning started with an overview of radiobiology from Michael Scholz (GSI, Darmstadt, Germany) (figure 2). They reiterated that while carbon ions and protons behave similarly in patients, they vary greatly in their relative biological effect (RBE) and accounting for this when planning with carbon ions is much more complex than for protons where the RBE is assumed to be constant with depth. Dr Scholz described how RBE for carbons is highly dependent on energy, LET (linear energy transfer), dose per fraction, cell type and the biological end-point, and introduced the local effect model (LEM) which HIT has adopted for carbon ion treatment planning (figure 3). Later that morning, Thilo Elsässer (GSI, Darmstadt, Germany) elaborated on the LEM and how it is based on the premise that the local effect due to ions is the same as that of photons, because the majority of damage is still carried about by secondary electrons (or δ-rays). He ended by saying that the latest version (IV) of the LEM is in preparation for publication.

Treatment planning techniques were a recurrent theme (and also later in the scientific session), as well as how to cope with range uncertainties and inter- and intra-fractional motion. Tony Lomax (Paul Scherrer Institut, Switzerland) described several different scanning beam algorithms for achieving highly conformal proton therapy: optimisation of each treatment field (single-field uniform dose), distal edge tracking, and optimisation of all Bragg peaks from all directions, all of which gave identical final plans. Professor Lomax went on to show that introducing deliberate range variations into these plans resulted in very different dose–volume histograms for each algorithm, with varying degrees of overdosing to organs at risk. By choosing the most robust plan, misplaced dose due to movement could be significantly reduced.

Christoph Bert (GSI, Darmstadt, Germany) also discussed the well-known interplay effect with scanned beams and organ motion, which results in a ‘patchy’ dose field with hot and cold spots in the tumour. He also explained the concept of an internal target volume (ITV) used by many radiotherapy departments to incorporate the changing clinical target volume (CTV) at
different points of motion, but illustrated how that didn’t solve the problem for scanned beams. His suggested solutions were fast rescanning (around 15 times), beam gating and increased pencil beam overlap.

EDUCATIONAL SESSION (CLINICAL)
Of interest in the clinical session were the talks given by Jean-Louis Habrand (Centre de Protonthérapie d’Orsay, France) and Stephanie Combs (University of Heidelberg, Germany) on paediatric malignancies. Professor Habrand noted that tumours in children are quite different to those of adults, and there is an even higher emphasis on quickly responding with treatment and keeping integral dose to normal tissues as low as possible. His view was that the role of protons should be mainly to escalate doses of selected radio- and chemo-resistant tumours and to improve quality of life, and highlighted the importance of spot scanning to reduce secondary cancer probability. Dr Combs focused on the applicability of carbon ions, noting that generally they are not talked about in conjunction with treating children. She showed many cases of children whose faces had grown asymmetrically in the years following conventional treatment. She identified chordomas, low grade chondrosarcomas and osteosarcomas as possible carbon ion candidates and presented excellent results of 94 per cent local control in 5 years for skull base osteosarcoma, with excellent cosmetic outcome on the longest followed-up patient.

Hirohiko Tsuji (National Institute of Radiological Sciences, Chiba, Japan) presented clinical data of hypofractionation with carbon ions. He described how giving larger dose per fractions can actually improve the therapeutic ratio, and gave examples of excellent local control of hepatocellular carcinoma with treatment regimes between 32–39 GyE in just two fractions. Professor Tsuji also said that the low α/β ratio for prostates means it can be safely treated with a very short course, and that 51.6 GyE in 12 fractions had been found to have the best anti-tumour effect with least toxicity.

SCIENTIFIC SESSION
On Thursday, the session began with six talks from centres in Houston, Boston, Jacksonville, Loma Linda (all USA), Heidelberg and Chiba (Japan), each outlining their experiences and perspectives on particle therapy. To summarise this session briefly, Al Smith (MD Anderson, Houston, USA) explained that their centre was slightly isolated with it being ¾ mile from the hospital. This perhaps explained the surprising statistic that 69 per cent of their patients are self/directly referred to them, with just the remaining 31 per cent coming from the hospital. Hirohiko Tsuji (NIRS, Chiba, Japan) reiterated their strategy of hypofractionation, which enabled a much lower cost per treatment, putting the cost on a par with surgery and chemotherapy. He also mentioned the plans at Gunma University to develop a compact accelerator, ⅓ the size of the HIMAC accelerator used at NIRS. Jürgen Debus (HIT, Germany) enthusiastically stated the intention at Heidelberg to use their new multiple-ion gantry to do the first blind-patient phase I and II trials of protons versus carbon ions, using the same standards and beam delivery techniques. This will be of particular importance to the future of both treatment modalities.

For much of the day onwards, clinical and physics workshop sessions were run in parallel. Being primarily a physicist, I attended the latter in the very ornate Chambermusic Hall on the 2nd floor. Marco Pullia (Pavia, Italy) gave some interesting and innovative proposals for improving ion gantries, among them: rotating only 180° instead of 360°, along with a rotatable couch to reduce
room size; field patching, by moving the couch to fill the whole field which reduces the bending magnet aperture; having a mobile rather than fixed iso-centre thus reducing the radius of the gantry, and even going as far as moving the patient between floors!

Friday morning began with a split session regarding image-guided proton therapy (IGPT), with talks first on inter-fractional and then intra-fractional motion. **Håkan Nyström** (Skandion Clinic, Uppsala, Sweden) stressed that for protons, the lung problem is not solved by selecting non-moving tumours, changing margins, audio coaching and not even 4D CT as taking an average breathing pattern on one or two occasions is not good enough. Instead, he suggested a combination of repeated (possibly daily) imaging, adaptive planning, advanced audio-visual coaching, gating (or breath holding) and possibly even apnea during anaesthesia. **Marcel van Herck** (Netherlands Cancer Institute, Amsterdam, Netherlands) followed this by outlining correction concepts for motion. He warned of baseline shifts between fractions, and suggested a path for adaptive RT: starting with a conventional 10 mm plan for 5 days with cone beam CT carried out daily, then replanning every week with a 7 mm margin. His future vision for optimal procedures was to combine on-line shift corrections with off-line replanning, and he noted that protons require larger margins for movement than x-rays and electrons as their shallower lateral dose fall-off is more forgiving.

Lunchtime saw the opportunity for poster viewing (figure 4), and after quickly downsing my food I tethered myself to my poster entitled ‘GafChromic film spectroscopy of a laser-proton source’. With laser-plasma acceleration being one of the exciting fields of physics research talked about at this meeting, I wasn’t short of interest and had several fruitful discussions mainly with other physicists. It was unfortunate however that with over 150 posters on display, no more than 1½ hours (including lunch) was dedicated to viewing with authors present. The afternoon was full of intensive clinical talks, and so I took the opportunity for a break from the conference in order to see the sights of Heidelberg. The views from the castle grounds and platform that straddles the Neckar river were fantastic, and it was well worth the visit. Heidelberg also has many interesting old university buildings, amongst which is the student prison, a two-storey house used to detain students for usually minor infringements. Over the centuries, the walls (and ceilings!) have become completely covered in artwork and scribblings, usually involving the names and silhouette impressions of those who served time there. In more recent times, it was regarded as almost a rite of passage to spend time there whilst studying.

Saturday started with more clinical talks on brain and skull base tumours, followed by ‘free communication’ sessions. **Herman Suit** (Massachusetts General Hospital, Boston, US) aired his strong desire for phase III trials to compare protons with carbon ions, by keeping variables such as fractionation and delivery equipment the same, and investigating others such as the effect of different LET from the two ion species. His talk on the whole was quite profound and his message clear – that we need to be guided not by what we think, but by what we know from clinical data.

**Marc Münter** (HIT, Germany) presented some results on combining ~ 56 Gy IMRT with a 20 GyE carbon ion boost for inoperable adenoid cystic carcinomas, namely acute toxicity at the grade III level in only a small minority of patients, with the rest experiencing a more tolerable grade II or lower and no incidence whatsoever of grade III or IV late toxicities. His future proposals included weighting more of the dose towards carbon ions, and also combining the chemotherapy agent Erbitux®.

**—heo**

![FIGURE 2. Radiobiology experiments with laser accelerated particles.](image)
On a different topic, Stefan Schmidt (ACCEL, Bergisch Gladbach, Germany) discussed technical commissioning being a cost driver in particle therapy and related to his experience at the new Rinecker Proton Therapy Centre (RPTC) coming online in Munich. He pointed out that with 20 different energy steps between 70 and 250 MeV, 24 gantry angles and two spot sizes, the number of sample points grows to around 1,000 before you even include range shifters and/or ripple filters. This led to his notion that the developing of automation is critical to capping the cost of commissioning, and one example of this at RPTC is a new amorphous silicon panel detector, which feeds a 20 Hz data stream directly into a database while the computer controls the beam and gantry.

After the lunch break, the topic once again focused on IMPT and treatment planning issues. Tony Lomax added to his earlier contributions by showing a humorous but in fact important case of ‘the wrong underwear’—two scans of the same patient on different days revealed that wearing much tighter underwear (or trousers) can have a significant impact on the path-length in the patient to the tumour site, giving rise to yet another source of proton range uncertainty.

Towards the end of the session, Katia Parodi (HIT, Germany) and Frank Verhaegen (Maastricht University, Netherlands) presented the role and obstacles of Monte Carlo treatment planning (MCTP) for particle therapy. Dr Parodi emphasised the ability of MCTP to fully simulate nuclear fragments in carbon ion beams, and showed excellent agreement between depth dose curves with the FLUKA code and a standard treatment planning system (TPS) after tweaking the I-value for water in FLUKA to match the range given by the TPS. Dr Verhaegen focused on the method of importing CT data into a Monte Carlo simulation—essentially a problem of going from Hounsfield units to tissue composition and density. He indicated that the latter is more important to get right as the stopping powers are more sensitive to changes in density, and he described the benefits of using a dual energy CT system to separate information about density from atomic number.

The closing remarks followed the end of the session, after which the new PTCOG president, Dr Alejandro Mazal thanked Dr Debus and Dr Combs in particular for all their hard work in coordinating the conference, which was a great success. As well as the highly informative talks, I had the opportunity to talk to many other people in the field of particle therapy and establish some new research contacts. I would like to sincerely thank IPEM, the Institute of Physics, and the LIBRA consortium for funding my costs for this meeting.
PRODUCING THE RIGHT RESULTS

Science lies at the heart of all the many and diverse activities which are undertaken by IPEM members. It is all too easy to overlook this, when faced with economic pressures (the recession, implications for public sector spending, cost improvement programmes….) and operational pressures (18-week targets, research assessment exercises, recruitment difficulties….). It can be good to step back, take a different perspective, and reflect on the wider contributions made by scientists to healthcare. The Chief Scientific Officer’s annual conferences have now been running for 6 years, and have developed into just such an opportunity. During each of the last two conferences there were clear messages, from both the Chief Executive and the Medical Director of the NHS, that science and innovation are crucial to the success of healthcare organisations, and that scientists have a key role in ensuring the quality of services. Indeed, the NHS definition of quality is that care should be ‘clinically effective, personal, and safe’. All scientists will be able to contribute to the first and last of these dimensions, many will contribute to all three, and this definition of quality maps readily onto the areas and ways in which IPEM members work.

The Healthcare Scientist Awards, instigated by Professor Sue Hill and presented at the Chief Scientific Officer’s Annual Conference, also provide an opportunity to recognise excellence in the different dimensions of scientific activity. It was particularly pleasing to see IPEM members so well represented amongst recent prize winners. As well as the HCS awards for innovation (Professor Andy Beavis, Hull) and for research (Professor Nick Stone, Gloucester), Dr Alan Mackenzie (recently retired from Bristol) received a lifetime achievement award. All the winners, and indeed all those who were nominated, have set standards of excellence which are an inspiration to us all.

A major part of IPEM’s contribution to the development of scientific excellence is the organisation of scientific meetings, both the programme of individual specialist meetings and also our contributions to major national events such as UKRC, UKRO, and especially our annual Medical Physics and Engineering Conference (MPEC). Planning for the next series of MPECs is well advanced, and we can look forward to collaboration with the UK Bioengineering Society in Nottingham in 2010, and the potential for international collaboration with two Irish Societies and EFOMP in 2011. Beyond that, IPEM has also been invited to host the International Conference for Medical Physics in the UK in 2013, as part of the celebration of the 50th anniversary of the founding of IOMP. This will be an opportunity to bring a major scientific meeting to the UK and also to strengthen the international reputation of the Institute.

Looking ahead over a 5-year period, or even further, what lies in store for IPEM? Crystal ball gazing is never easy, but changes will certainly happen, and history suggests that successful organisations are those which can adapt and develop. To help guide these developments, the Trustees are currently reviewing the IPEM strategy. Why do we need one? Well, although we can be justly proud of the many achievements of the Institute, historical momentum is a poor strategic plan. To do in the future only what we have done in the past is a near guarantee of missed opportunities and declining activity. Formulating a strategy is not a well-defined process, it is necessarily abstract and imaginative rather than detailed and prescriptive. Some of the themes which have already been proposed for consideration include:

- What is our identity (professional body, learned society, or both)?
- How might we support research and innovation?
- How might we support and sustain training for scientists and technologists, given the likely changes defined by Modernising Scientific Careers?
- How should we make best use of our financial reserves?

I would encourage all IPEM members to take an active part in this process, either through Regional Chairs, or specialist groups, or by direct comment to the IPEM office. Your input will ensure that a wide range of views are represented, and the collective wisdom of IPEM members will give us the greatest potential for insight and analysis. I cannot resist another quotation from Churchill, which seems to me particularly apt for physicists and engineers: ‘However beautiful the strategy, you should occasionally look at the results’. It reminds us to apply the same standards of empiricism and evidential rigour to our professional activities as we do to our scientific work.
Y ou may not realise, but Scope is prepared several months in advance. Hopefully this issue will greet you on a warm spring day, but I’m writing this welcome, my first Scope editorial, with frost-bitten fingers in a drafty London hospital on Christmas Eve. Our Editor-in-Chief, Marc, handed the Scope reins for this issue to me as he prepared for a Joyeux Noël in France, but unfortunately a whole 3 mm of snow was enough to ground his aeroplane, forcing him to swap Père Noël for good old Saint Nick instead.

If the weather turns foul he may think of taking his family along to The Wellcome Collection in London where they showcase many collaborations between art and science. Originally ‘science’ and ‘art’ were considered to be two sides of the same coin and artists have often drawn upon the sciences for inspiration when their muse eludes them.

There is now an emerging new school known as ‘MRI art’ and in this issue we focus on a large installation recently erected at the University of Aberdeen Medical School on page 52. I’m sure you’ll share my hope that this may herald a new era of collaboration between the Arts Council and IPEM, or maybe not.

For the less culturally aware amongst us, we still have a diverse range of other features; Peter Clowes brings us the second part of his Weibull analysis article. Our regular contributor Jenny Freeman leads us together another excellent book review section, Azzam Taktak gives us feedback on what happened at IPEM’s 15th Annual Medical Physics and Engineering Conference and Christie McComb reports on a new device that may allow us to curtail all that hand washing in hospitals.

I hope that you enjoy this issue, next time Marc will be back at the helm and everything will be back to normal.
Stone imaging

In current clinical practice, it is possible to differentiate between uric acid kidney stones and non-uric acid kidney stones. However, there are in fact many different types of kidney stones, and more accurate classification could lead to improved management of patients. Results of a prospective phantom study which investigated the non-invasive assessment and classification of kidney stones were recently presented.

The research was carried out using a dual-source CT system which operated at 80 and 140 kV, with a tin filter added to the 140 kV tube to provide increased energy separation between the two spectra. Sixty human renal stones of ten different types, whose true composition was determined using micro CT and infrared spectroscopy, were embedded in porcine kidneys and placed into a water phantom with a cadaver spine. Images were obtained using the low and high energy settings, and the CT numbers for the stones calculated for each image. The dual energy ratio (DER), which is the ratio of the low to high CT numbers, was then calculated and used to characterise stone type.

The researchers found that it was possible to separate the ten types of stones into four primary groups, a significant improvement from the two-class discrimination technique currently used. While some types of stone are amenable to lithotripsy, other types are very difficult to break up non-invasively and require surgical intervention and the information provided by this technique could therefore assist in the triage of patients.

This story was reported on Aunt Minnie on 4th January, and further information can be found at:
http://www.auntminnie.com/index.asp?Sec=sup&Sub=cto&Pag=dis&Itemid=88958

Pancreatic cancer screening using optical spectroscopy

The 5-year survival rate for pancreatic cancer is very low, mainly due to the fact that no reliable diagnostic procedure has been developed for detection of early stage disease. The current diagnostic standard is endoscopic ultrasound-guided fine needle aspiration (EUS-FNA), which only has a 54 per cent sensitivity for cancer in the presence of pancreatitis. Previous studies in animals have demonstrated that the use of optical techniques such as fluorescence spectroscopy can be used to quantitatively distinguish between different tumour regions, and a research team at the University of Michigan have now carried out a similar study in human pancreatic tissue [Opt Express 2009; 17(20) 17502-16].

The Reflectance and Fluorescence Lifetime Spectrometer (RFLS), developed at the University of Michigan, was used to obtain reflectance and fluorescence measurements from freshly-excised human pancreatic tissue from two patients. Histological samples from one patient revealed pancreatitis in some areas and normal pancreatic tissue in others, and samples from the other patient showed the presence of pancreatic cancer in all areas. The reflectance and fluorescence spectra obtained from the three tissue types were noticeably different, and therefore could potentially be used as a diagnostic indicator for pancreatic cancer.

The researchers developed mathematical models of reflectance and intrinsic fluorescence to allow interpretation of the differences in spectra for different tissue types. They found that the reflectance model was most useful for discriminating between pancreatic cancer and chronic pancreatitis, while the fluorescence model was more effective at distinguishing between all three tissue types. Combining reflectance spectroscopy and fluorescence spectroscopy may offer a diagnostic advantage over using just one of these modalities to detect pancreatic cancer.

This story was reported on Medical Physics Web on 27th October, and further information can be found using the following link: http://medicalphysicsweb.org/cws/article/research/40779

Optical techniques can be used to detect pancreatic tumours
Plasma dispenser for hospital disinfection

HandPlaSter device

Disinfection and sterilisation in hospitals is of increasing concern due to the rise in hospital-acquired infections such as MRSA and C. Diff, and the increase of antibiotic-resistant bacteria. The current method of bacterial containment involves the use of liquid disinfectant by hospital visitors and staff. However, the issue of hand disinfection can be daunting – on a typical working day around 60 to 100 disinfections are required in principle, each of which should take 3 minutes, which means a total of 3 to 5 hours spent on disinfection. In addition, there are a number of side effects due to mechanical, chemical and possibly allergic irritations to the skin.

Sterilisation of equipment using plasmas, which are gases of ions and free electrons, is a well-established technology in medicine. Plasma sterilisation devices work at the atomic/molecular level and are therefore able to reach surfaces which are not accessible to fluid disinfectants. The design of such devices has previously made them unsuitable for use on the human body, but a team of researchers at the Max-Planck Institute for Extraterrestrial Physics in Garching have published a paper describing the development of a new atmospheric plasma dispenser which is specifically designed for disinfection of large areas e.g. the hands (New J Phys 2009; 11: 115019).

The plasma dispenser contains a new design of electrode, which consists of three layers – a copper sheet electrode, a Teflon plate and a stainless steel wire mesh electrode. Two electrodes are positioned with a separation of 4 cm, and when a voltage is applied to the copper electrode, plasma is produced in the squares between the wires of the mesh electrode. Interactions between the plasma and water vapour in the air produce reactive oxygen and nitrogen species, including ozone, nitrogen oxide and hydrogen peroxide, which together kill bacteria.

The team have demonstrated that the device operates far below the WHO safety levels for UV, toxicity and electromagnetics, and they suggest that devices of this type could become a major weapon in the fight against hospital-acquired bacterial infections in the future.

This story was reported on Physics World on 26th November, and further information can be found using the following link:

Alliance for MRI update for 2010

The EU Physical Agents 2004/40/EC (EMF) was created to provide minimum health and safety requirements relating to the exposure of workers to EMFs. However, there is concern that the proposed legislation will severely curtail the clinical and research use of magnetic resonance imaging (MRI), particularly in interventional applications and in imaging vulnerable patients and children where closer patient contact is required.

The Alliance for MRI is a coalition of European Parliamentarians, patient groups, scientists and the medical community who are seeking to avert the threat to the future of MRI and to ensure that patients in Europe will not be precluded from state-of-the-art healthcare services.

The European Commission is preparing its proposal to amend Directive 2004/40/EC, and the proposal is expected to be adopted by the College of Commissioners by April 2010. There is still a widespread lack of understanding regarding the implications of the EU legislation on the use of MRI, and therefore in 2010 the Alliance for MRI will be working with all its members to ensure that the potential threat is well understood amongst key decision-makers in the European Commission, European Parliament and the member states. Towards this end, the Alliance for MRI held a very successful annual meeting and reception in the European parliament on 13th October 2009, which was hosted by two leading MEPs.

Further information, including press releases, related to this story can be found on the Alliance for MRI website:

IN BRIEF

PANCREATIC CANCER SCREEN
Optical techniques such as fluorescence spectroscopy have been trialled in human pancreatic tissue to detect tumours. Reflectance and fluorescence measurements were obtained from samples and the different spectra could potentially be used as a diagnostic indicator for pancreatic cancer.

PLASMA HAND STERILISER
A team of researchers have described the development of a new atmospheric plasma dispenser. Sterilisation using plasmas, gases of ions and free electrons, has been used on equipment and the new design is specifically for disinfection of large areas such as hands. This could be a major breakthrough in the fight against hospital-acquired infections and antibiotic-resistant bacteria.

DUAL-SOURCE CT IMAGING
There are many different types of kidney stones, and dual-source CT can be used non-invasively to assess and classify different types. Images were obtained using a dual-source CT system with high and low energy settings, and calculations of the dual energy ratio were made to determine the stone type.

ALLIANCE FOR MRI UPDATE
The Alliance for MRI aims to safeguard the future use of MRI in Europe through an EU-wide exemption for the medical use of MRI and related research from any exposure limit values set. A successful recent meeting started their 2010 campaign to highlight these issues.
<table>
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<tr>
<th>Meeting</th>
<th>Dates</th>
<th>Venue</th>
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<tr>
<td>16th UK Monte Carlo User Group Meeting (MCNEG 2010)</td>
<td>12th–13th April</td>
<td>National Physical Laboratory (NPL), UK</td>
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<td></td>
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<td>Further information regarding this meeting, details of registration and submission of abstracts, and preliminary programmes can be found on the website at: <a href="http://www.npl.co.uk/events/12-+-13-apr-mcneg-2010">www.npl.co.uk/events/12-+-13-apr-mcneg-2010</a></td>
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<tr>
<td>11th International Workshop on Electronic Portal Imaging</td>
<td>7th–8th June</td>
<td>Leuven Belgium</td>
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<td>This year with the added focus on in-treatment verification. Your contribution can be submitted using the submission form on the website: <a href="http://www.epi2kx.org">http://www.epi2kx.org</a></td>
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<td>The website of course also holds more information on the conference.</td>
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<td>Note this workshop is being organised in co-operation with the conference on the use of computers in radiation therapy (ICCR 2010: <a href="http://www.iccr2010.org">http://www.iccr2010.org</a>) which is to be held a week beforehand in Amsterdam, The Netherlands. This is about a 2 hour drive away from Leuven.</td>
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<tr>
<td>6th IET International Seminar on Appropriate Healthcare Technologies for Developing Countries (AHT 2010)</td>
<td>13th May</td>
<td>IET, Savoy Place, London</td>
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<td>Speaker: Sir Liam Donaldson, Chair WHO Patient Safety</td>
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<td>The format of this year’s event differs from previous years. The launch of the event will take the shape of an evening meeting. Those unable to attend will have the opportunity to submit a paper/presentation which will be accessible from the event website. Discussion will then be held electronically using the Listserv INFRATECH (<a href="http://listserv.paho.org/archives/infratech.html">http://listserv.paho.org/archives/infratech.html</a>). This will enable participation by field workers all over the world.</td>
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<td>On the evening itself, following the keynote address from Sir Liam Donaldson there will be a platform to exhibit posters allowing presenters and researchers to view one another’s work.</td>
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<td>The event will be held in collaboration with WHO Patient Saftey and IPEM</td>
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<td>For more information, and to register for the event, visit: <a href="http://www.theiet.org/aht2010">www.theiet.org/aht2010</a></td>
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<tr>
<td>First Global Forum on Medical Devices, linked with the Global Initiative on Healthcare Technologies</td>
<td>15th–17th September</td>
<td>Thailand</td>
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<td>The aim of this conference is to raise awareness on the role of medical devices in health, to share knowledge on available resources, tools, guidelines and their use and to foster interdisciplinary partnerships.</td>
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There are some places still available on the MEiGaN course taking place on 22nd and 23rd February at the Trans-Euro Engineering Training Centre. For full details and a booking form please go to: www.trans-euro.co.uk
SOME TEACHING RESOURCES AVAILABLE ONLINE:

<table>
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<tr>
<th>URL</th>
<th>Details</th>
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<tr>
<td><a href="http://www.teachingmedicalphysics.org.uk/">http://www.teachingmedicalphysics.org.uk/</a></td>
<td>Includes interactive planning of RT, also PET, functional MRI and colonoscopy!</td>
</tr>
<tr>
<td><a href="http://ehealthlearning.org.uk/arena/index.cfm">http://ehealthlearning.org.uk/arena/index.cfm</a></td>
<td>An e-learning package from the HPA covering major incidents. It’s useful to see what other agencies will be doing when planning your own response.</td>
</tr>
<tr>
<td><a href="http://www.sciencedump.com/content/wc-%C3%B6ntgen-and-x-rays">http://www.sciencedump.com/content/wc-%C3%B6ntgen-and-x-rays</a></td>
<td>Roentgen re-enactment.</td>
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For general information on policies, recommendations and guidelines on Healthcare Technology Management, see the new WHO e-documentation website: [http://infocooperation.org/healthtechdocs](http://infocooperation.org/healthtechdocs)

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CLASSIFIEDS

A free medical physics classifieds website has recently been launched: [www.medphysclassifieds.com](http://www.medphysclassifieds.com)

The hope is that it will provide a central location for buying and selling new/used medical physics equipment among other things (wanted, services, education, etc.). If anything, it might help clear out the physics storage room!

(Note: for used medical equipment, there exists a service at [http://www.biomedea.org/HTTTG/donations.htm](http://www.biomedea.org/HTTTG/donations.htm) under the aegis of the IFMBE. This aims to provide advice on the suitability of offered medical equipment to the environment proposed.)

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FOOTBALL WORLD CUP

As some of you may be aware, South Africa is hosting the 2010 soccer world cup. The final draw has been made and all soccer enthusiasts are rushing to get tickets and finalise their travel arrangements. Our local medical physics community sees this as an ideal opportunity to build up relations between like-minded medical physicists.

I am therefore inviting any medical physicist / soccer lover who is thinking of visiting our beautiful country to contact me. There are a number of levels in which we can get involved in making your stay here more memorable.

These are:

1. We can arrange guest lecture(s) at our training institutions, the trip can then become a business trip with associated tax perks!

2. We can help with accommodation and travel arrangements even if it is simply advice when making a choice.

3. We can give you contact details of colleagues in the city(cities) where you will be staying so that there is a support base for you to fall back on in case of a vehicle breakdown or if you simply want to know where to get the best pizza.

4. We will gladly field your questions on any concerns you may have.

We see this as an ideal opportunity to extract more value for all out of this huge event.

Professor Ado J van Rensburg  
Director: Medical Physics  
Steve Biko Hospital (formerly Pretoria Academic Hospital)  
avanrens@MEDIC.UP.AC.ZA

PS There used to be a Scope magazine in South Africa. It was the only magazine with half nudes (appropriately covered with censor’s stars) but did cover some real news events as well. I include a few covers I could find.
Obituary: Aled Evans

Dave Wyper and Donald Smith look back on the full life of an inspiring colleague

Aled Evans lived life to the full.

Aled Evans worked in the Department of Clinical Physics and Bioengineering in Glasgow for 38 years. Aled had always been healthy and active and so it was a surprise and a shock to all his friends and colleagues when he was diagnosed with a brain tumour over 2 years ago. He survived far longer than predicted, and did so with dignity, fortitude and good humour.

All of us who worked with Aled will remember him with affection and with considerable respect. Being in his company was always a warm experience. You felt relaxed, but also stimulated by his thought and perception. He would seldom argue with you. Instead, the look in his eye told you that he did not completely approve of your proposal. That was enough. We all had great respect for his judgement.

For someone who joined the department as an expert in radiation physics, Aled, in response to demand, rapidly developed expertise in medical electronics. From this setting, Aled helped to develop not only electronic instruments, but also the careers of trainee scientists and technologists. He set about training with knowledge and conviction, teaching and organising several courses.

Aled loved Scotland – almost as much as he loved being Welsh. The message on his answer machine was in Welsh, and why not. They all say the same thing and so it doesn’t matter if we know what each word means. He translated many of his publications into the Welsh language. This was more to do with his proud patriotism than an attempt to increase his publication list. He had no need to do that. From an NHS setting, he produced an impressive range of products and publications.

As head of the Medical Electronics Development Service within the department, Aled’s forte was instrumentation software. With his customary sound judgement he recognised that his small section could not be world experts in everything and so he focused the work of his team on two niche areas. The team was pro-active in the development of test equipment for medical devices and also reactive in responding to specific projects brought by clinicians who identified the needs of patients in various settings.

The test instruments produced in this setting have been well described in several publications: ‘An instrument for scanning the angular variation of irradiance in ultraviolet phototherapy cabinets’, ‘An instrument for testing external cardiac pacemakers’, ‘A method for testing volumetric pumps’ and ‘Microprocessor-controlled signal generator for the functional testing of electrocardiographs’. The medical devices that he developed range from the Easicom, developed for elderly patients in hospitals with hearing deficits, to the Pocket Speech Aid for clients with communication impairment, the Ultratimer to assess movement, and, most recently, the SightSim project developed along with colleagues at Yorkhill for carers of children with visual impairment (www.sight-sim.co.uk).

It is sad that Aled did not live to enjoy a period of retirement. He did, however, enjoy many happy years with his family and friends and a very fulfilling professional career that has benefited countless patients and colleagues in clinical physics. Our thoughts are with Aled’s wife Joan and his children Charel and Gareth.

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IPEM FORTHCOMING CONFERENCES 2010

<table>
<thead>
<tr>
<th>Conference</th>
<th>Dates and venue</th>
<th>More information</th>
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<tr>
<td>Experiences and Optimisation of Multicentre MRI Research Studies</td>
<td>26th March 2010 Edinburgh Training and Conference Venue</td>
<td>Multicentre MRI is an increasingly popular approach for acquiring large datasets from diverse geographical populations, yet technical issues in combining data from multiple sites need to be addressed. At this meeting, practical approaches to these problems will be discussed in addition to results from existing clinical and research multicentre studies.</td>
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<tr>
<td>Head and Neck Cancer: Advances in Radiation Treatment</td>
<td>30th April 2010 The Geological Society, London</td>
<td>Technical advances in radiotherapy such as IMRT and IGRT, along with new chemo-radiation regimes, are providing greater ability to preserve organs, increase survival rates and improve patients’ quality of life. This meeting provides the opportunity to discuss developments and future directions in the treatment of head and neck cancer.</td>
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<td>New Analytical Tools in Clinical Gait Analysis for Better Patient Outcomes</td>
<td>6th May 2010 Fairmount House, York</td>
<td>One of the challenges to scientists and engineers working in movement analysis is to make the data they receive more meaningful to clinicians. This event will provide an opportunity for scientists, engineers, doctors and physiotherapists to exchange ideas and present new results. The aim is to encourage dialogue between professionals from different backgrounds in this multidisciplinary area of research and practice.</td>
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Further details of all forthcoming conferences can be found at www.ipem.ac.uk
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<td>Clinical Scientist</td>
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<td>Terence Michael Rahoe</td>
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<td>16 Nov 09</td>
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<tr>
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Medical physicist becomes a work of art and gives away his honours

J. R. Mallard describes some incredible artwork and a very generous donation

In case you hadn’t realised that MRI could have anything to do with art, the installation consists of a large number of acrylic sheets suspended on stainless steel wires, each sheet imprinted with an MRI transverse section – using a modified IR sequence – across the bodies of John Mallard, and a Mr Suttie who made a very generous donation towards the cost of the building, as shown in the photograph. A 3D effect is created showing John reaching down from the top to touch Mr Suttie reaching up from the bottom, rather reminiscent of Michelangelo’s God creating Adam in the Sistine Chapel. Not that I am suggesting that John be deified! In fact the whole structure is meant to provide a permanent reminder of the work carried out on the site by medical physicists who pioneered MRI.

Creating the work was less than straightforward as it proved difficult to get John’s bent back into the 3T imager. The first set of images showed him without a head so a second session had to be arranged to put his head back on again! He claims to be the first person to survive beheading!

Also, at a special ceremony, John presented all 30 of his Honours – medals, awards and plaques – to the President of the Aberdeen Medical-Chirurgical Society as a gift in perpetuity. The Society, which promotes medical education and hosts many scientific meetings in its rooms adjacent to the Medical School, was founded in 1789 and is one of the oldest medical societies in the world: it has a collection of portraits, medical artefacts and archives, which is of national importance. When making the presentation, John paid tribute to the dedicated teams of people who had carried out the work, some of whom were present at the ceremony and he added, ‘It is very natural that Fiona, my wife, and I should wish to leave, with the Med-Chi here at Foresterhill, some real evidence of the pioneering work, towards the creation of modern medical imaging, which was carried out here at Foresterhill, from 1965 onwards. I think that nuclear medicine imaging of patients, and magnetic resonance imaging (MRI), are here to stay in medicine, but, already, the vital contributions made here in Aberdeen are beginning to fade in people’s memories.

So Fiona and I hope that the medals and awards, which have been given to me, will serve as a permanent reminder of the terrific stir and excitement which that work caused at the time, in the scientific and medical worlds. The medals are just symbols of the recognition given to that work, when its significance was realised.’

The 30 awards include: two Gold Medals, 1984 and 1990, from the Royal Society [London]; the Royal Gold Medal of the Royal Society of Edinburgh, 2002; the Gold Medal of the Royal College of Radiologists, 2004; the OBE, 1992; two medical awards from Europe (including the George van Hevesy Medal, 1984, and the EFOMP Medal, 2004), and three international awards, including one from Japan.

In accepting the awards, the President of the Med-Chi said that it was planned that they would be exhibited in the Centre for Teaching and Learning in Healthcare, together with other items from their archives.
Topics in Accelerator Health Physics

First impressions of this text are that it has only peripheral relevance to the medical physics community; however, closer inspection reveals it to be a valuable addition to a departmental book-list, albeit a highly specialised one.

The first chapter on beam physics and accelerator architecture has both qualitative and quantitative analyses of beam control which would be relevant to linac and cyclotron physicists where a deeper understanding of device design could be important but is most likely to appeal to research applications. Chapter 2 discusses the production of radiation fields in accelerators and includes an analysis of neutron production which is an important concept in modern linac design, especially at the higher energies.

Chapters 4, 5 and 6 are particularly useful in that they discuss protection, monitoring and shielding of high-energy beams which includes energies found in therapeutic applications and isotope creation. These chapters provide insight into the design and monitoring arrangements for facilities using high radiation fields but there are sections such as how to manage ducts and penetrations which clearly are of relevance either to new build or modification to established facilities. In addition to the expected attenuation calculations, information on managing abnormal operating conditions and the practicalities of dose limitation are covered although with some comments relating to legislation that are clearly intended for the American markets.

Chapters 8 and 9 are, however, more likely to be of primary interest to the practicing medical physicist in that they concentrate on medical application of therapy or isotope manufacture. They include discussion on QA, documentation, traceability and dosimetry all based on the concepts established in previous chapters.

The final two chapters are interesting in their own right since they present analysis of the interaction of radiation beams with solids and also some case studies with analysis of faults and incidents which are useful to study in the light of the UK framework of control. In fact it is a useful exercise to case study the presented incidents with an eye on how they would be addressed in the UK.

Overall, this book can be heavy going since it is derived from a specialist professional development course but nevertheless is recommended as a means of extending current knowledge. Anyone without a working knowledge of linacs or cyclotrons would find it a bit indigestible and it is certainly not one for trainees unless for insight into the finer workings of beam control. The only real criticism is that the quality of the non-text elements is poor; some of the graphs are almost impossible to read and some of the images have not been reproduced well enough to be of use. One for the central medical physics library.

Malcolm Sperrin, Director of Medical Physics at the Royal Berkshire Hospital

TOPICS IN ACCELERATOR HEALTH PHYSICS

J. DONALD COSSAIRT, WASHEK VYLET AND JOHN W. EDWARDS.

Publisher: Medical Physics Publishing Corporation (December 2008)
ISBN: 978-1930524378
Pages: 309
List price (from Amazon): £26.06

Cancer Mortality and Morbidity Patterns in the U.S. Population: An Interdisciplinary Approach

This is an excellent text authored by three specialists from different disciplines – demography, theoretical and mathematical physics and internal diseases/biochemistry.

The opening chapter introduces the reader to a short historical timeline of cancer: origins, discoveries, the first oncologist and the first cancer hospital as well as more recent developments. The following chapter considers the cellular aspects of cancer, theories and models of carcinogenesis (including hallmarks of cancer) and heterogeneous population models as well as limitations of study types and analyses. Chapters 4 and 5 cover stochastic and non-stochastic methods of analysing mortality and morbidity data and provide a basis for mathematical analysis. Chapters 3 and 6–9 cover cancer risk factors, in-depth site-specific trends in the USA, modelling age patterns of cancer histotypes, risk factor intervention and cancer prevention. The authors provide an excellent insight into controllable and non-controllable cancer risk factors. They put emphasis on adopting a microsimulation model to aid cancer prevention in addition to advocating that ultimate success can be achieved through interdisciplinary team work. A number of solutions are provided that would steer current research and might result in breakthroughs. Cancer prevention strategies cover factors such as smoking, obesity, diet, physical exercise and alcohol consumption.

This really is a marvellous piece of work, which should provide scientists with key strategies that will lead to successful research outcomes and the much-needed ultimate breakthrough in cancer. It is a very highly recommended text for any professional associated with the field of cancer.

Republished (in part) from: Cancer Mortality and Morbidity Patterns in the U.S.

Usman I. Lula

CANCER MORTALITY AND MORBIDITY PATTERNS IN THE U.S. POPULATION: AN INTERDISCIPLINARY APPROACH
KENNETH G. MANTON, IGOR AKUSHEVICH AND JULIA KRACHENKO
Published by: Springer Science & Business Media (2009)
ISBN: 978-0-387-78192-1
455 pages
List price: £51.00

News
Some useful IAEA publications for the year 2009 (accessible electronically via http://www.iaea.org/Publications/index.html) are listed as follows:

- Dose Reduction in CT while Maintaining Diagnostic Confidence: A Feasibility/Demonstration Study; IAEA TECDOC Series No. 1621, 2009
- Quality Assurance for SPECT Systems; IAEA Human Health Series No. 6 STI/PUB/1394, 2009
- Release of Patients After Radionuclide Therapy; Safety Reports Series No. 63; STI/PUB/1417, 2009
- Security of Radioactive Sources; IAEA Nuclear Security Series No. 11, 2009
- Calibration of Reference Dosimeters for External Beam Radiotherapy; Technical Reports Series No. 469, 2009

Fundamentals of Medical Imaging (2nd edition) by Paul Suetens (Cambridge University Press) is an invaluable technical introduction to each imaging modality, explaining mathematical and physical principles, image acquisition and interpretation. Individual chapters on each modality review the physics of the signal, image formation/reconstruction, image quality and equipment, clinical applications, biological effects and safety issues.

Statistics of Medical Imaging by Tianhu Lei (Taylor & Francis Ltd) fills the gap in the literature to provide a unified framework of study. It presents a complete look at medical imaging and statistics, from the statistical aspects of imaging technology to the statistical analysis of images. It provides technicians and students with the statistical principles that underlie medical imaging and offers reference material for researchers involved in the design of new technology.

The Physics of Medical Imaging (2nd revised edition) by Steve Webb (Taylor & Francis Ltd) reviews the scientific basis and physical principles underpinning imaging in medicine. The major imaging methods of x-rays, nuclear medicine, ultrasound and nuclear magnetic resonance are covered. Following these reviews are several mathematical chapters which cover the maths of medical imaging, image perception, computational requirements and techniques.

Radiation Protection in Medical Radiography (6th revised edition) by Mary Alice Statkiewicz-Sherer, Paula J. Visconti and E. Russell Ritenour (Elsevier Health Sciences Mosby) provides vital information on radiation protection and biology in a clear, concise and easy-to-understand manner. Building from basic to more complex concepts, this book also presents radiation physics, cell structure, effects of radiation on humans at the cellular and systemic levels, regulatory and advisory limits for human exposure to radiation, and the implementation of patient and personnel radiation protection practices.

SPECT Basic Science and Clinical Applications by Dale L. Bailey and Steven R. Meikle (Springer London Ltd) is claimed to be the most complete book on single photon emission computed tomography (SPECT) fundamentals published to date. It brings together the theory, physics, instrumentation, image processing and quality assurance aspects necessary to understand and perform high quality SPECT. The text is suitable for radiologists, physicists, engineers and technologists working with SPECT technology.

Just Published!

Get Through First FRCR: MCQs for the Physics Module by Grant Mair, Andrew Baird and Andrew Nisbet (The Royal Society of Medicine Press Limited) is the essential revision tool for all First FRCR candidates preparing for the newly-revised examination. Over 200 five-part true/false MCQs are presented according to syllabus topics, accurately reflecting the content, style and level of difficulty of the actual examination questions.

Basic Health Physics: Problems and Solutions by Joseph John Bevelacqua (John Wiley and Sons Ltd) is designed to prepare candidates for the American Board of Health Physics Comprehensive examination (Part I) and other certification examinations. It introduces readers to radiation protection principles and their practical application in routine and emergency situations. It features more than 650 worked examples illustrating concepts under discussion along with in-depth coverage of numerous areas.

REVIEWERS WANTED!

Being a Scope book review editor is a funny old business. One minute you have no books on your desk and you’re worrying about where your next copy is coming from. Next minute there is an avalanche; you receive a package of books every day and the tower on your desk becomes higher and higher.

A way to make the whole process a bit easier is to have a good group of reviewers ready and waiting. We have recently been in consultation with the IPEM special interest groups, and they are willing to help us create a group of keen reviewers who we may refer books on to.

We need more than this however and this is where you come in. If you have seen a book in Just Published! that you might like to review, please drop us a line and we will try and get a copy for you, likewise with any recent book in print. You may also decide that you would like to be a reviewer but are unsure what to review. Please contact us and we could match you with a book. Either way, as a thank you, you get to keep the book. We don’t operate short deadlines, therefore allowing you to review at your own pace.

Popular Science is our newly launched column, and again we are on the lookout for reviewers. This time we cannot call on the SIGs for help so this is where volunteers like you are especially needed. Popular Science books are generally shorter and easier to read in one go, making them ideal for time-short reviewers, and again you would get to keep the book.

There are advantages to doing book reviews for Scope; in addition to increasing your library, it counts towards valuable CPD, and as a more junior member of IPEM it may be a good addition to your CV.

So please, we ask you to consider becoming a Scope book reviewer, it takes little time, there are clear benefits and it would make our lives easier!