ACMD

Advisory Council on the Misuse of Drugs

Consideration of the use of Multi-Criteria Decision Analysis in drug harm decision making.

Table of Contents

1. Scope and Preface

The Advisory Council on the Misuse of Drugs (ACMD) is a Non-Departmental Public Body (NDPB) that has a statutory duty to advise, and to consider any matter referred to them by ministers, on drug related issues in the UK; on their control, classification and scheduling under the Misuse of Drugs Act 1971 and its Regulations.

To set this report in context, the drugs landscape is rapidly changing in light of the well reported increased use of new psychoactive substances ('legal highs'). It is a continuing challenge to consider the harms of new psychoactive substances, particularly when the evidence base concerning their harms is not as well developed as that of many long standing drugs of misuse.

The purpose of the work in this report is to improve the framework for providing advice to ministers on the harms of drugs. The ACMD considered that this work would not seek to update or revisit the present classification system of drugs, but would serve as a tool to augment the ACMD's deliberations and judgements in this challenging field.

In this report the ACMD considered the use of Multi-Criteria Decision Analysis (MCDA) to support the process of developing a framework. MCDA is often used in such situations where decision makers need to derive a transparent outcome, but in an environment where there may be many and sometimes conflicting evaluations. The technique of MCDA aims to address these conflicts and derive a compromise. The process is based on developing a list of criteria and, using evidence, formulating judgements and then preferences to derive an outcome. The process is therefore subjective and different users of the model may derive different outcomes on the same evidence dependent on their preferences (although the importance of different preferences can be tested through sensitivity analyses). However, using MCDA increases transparency by allowing others to see the process by which decisions have been derived. The key part to the model is the development of criteria that express the ways in which substances can be harmful, which comprise of physical, psychological and social harms.

By publishing this methodological report the ACMD consider it will provide the opportunity for individuals and organisations to consider the criteria and to refine this approach in the future.

2. Executive Summary

The ACMD has explored the use of a multi-criteria decision analysis (MCDA) model for evaluating drug harms. The model provides a conceptual framework for further consideration and refinement. This approach could provide a basis for exploring and formulating recommendations to ministers as part of the structure of ACMD reports. The ACMD recognises that further and on-going development of the model is necessary, particularly as society and drugs of misuse change. The model presented should be considered as illustrative rather than absolute.

The ACMD developed 16 criteria that express the ways in which substances can be harmful, which comprised physical, psychological and social harms. Each criterion was carefully defined and assigned an agreed weighting to enable drugs to be meaningfully evaluated.

Using the model requires evidence to evaluate the harms of a substance against each criterion and subsequently judgements to be made on the relative importance of the criteria. For example, whilst there can be robust scientific evidence of the harm caused by a substance, there is no evidential basis that will indicate whether ‘drug-related crime’ is more or less important than ‘drug-related mortality’. The latter are value judgements which will depend on an individual’s standpoint and the purposes for which the model is being used (e.g. value judgements will change if the model is being used to determine the allocation of economic resources, compared to developing a legal framework).

The report describes the model and how it may be used in a decision making context.

3. Introduction

This report presents a method for considering the relative harms of substances using a Multi Criteria Decision Analysis (MCDA) model. The Advisory Council on the Misuse of Drugs (ACMD) held two meetings on 23 - 24 March 2009 and on 19 June 2009 to develop an initial model for appraising and evaluating drug harms and the model was considered further at subsequent ACMD meetings.

The decision conferencing format (Philips, 2007) that was adopted for developing the model provided a structure for deliberative discourse (Renn, 1999) among ACMD members, enabling them to challenge shared assumptions and develop new perspectives.

A list of current ACMD members is provided in Appendix 1.

4. MCDA Methodology

Comparators

In order to develop the MCDA model the ACMD defined 1) a range of criteria covering the harms that characterise the drugs under consideration, and 2) an initial set of evaluations and weighting for each criterion.

To develop the structure of the model the ACMD discussed the substances that would need to be sufficiently discriminated by the model. Proof of concept for the model was piloted using representative inputs for a number of drugs. However, it was decided not to take this preliminary test any further at this stage as objective evidence from, for example, intelligence and scientific literature was not available for these across all the criteria.

Criteria

Sixteen criteria were developed to assess the harms of drugs. Nine criteria fell under the heading of harms to the user and the remaining seven under harms to others. These were further divided between physical, psychological and social harms. A value-tree representation of the criteria and their clusters is shown in Figure 1[1].

The tree shows objectives at the nodes, and criteria against which the drugs are to be evaluated at the extreme right (definitions are provided in Table 1). Thus, the main objective is to determine an ordering of the drugs at the OVERALL HARM node. The next level to the right provides separate orderings TO USERS (harm to those who are using the drug) and TO OTHERS (harm as a consequence of the use of drugs to others both directly and indirectly). Each of these is broken down according to the PHYSICAL, PSYCHOLOGICAL and SOCIAL orderings.

To assess the harm of any individual substance (or group of substances) evidence for the degree of harms would be required for each of the criteria at the extreme right of the value tree.

[1] The value tree and all subsequent aspects of the model were implemented in Hiview 3, a computer program originally developed at the London School of Economics. It is available from the current developers, Catalyze Limited, at www.catalyze.co.uk.

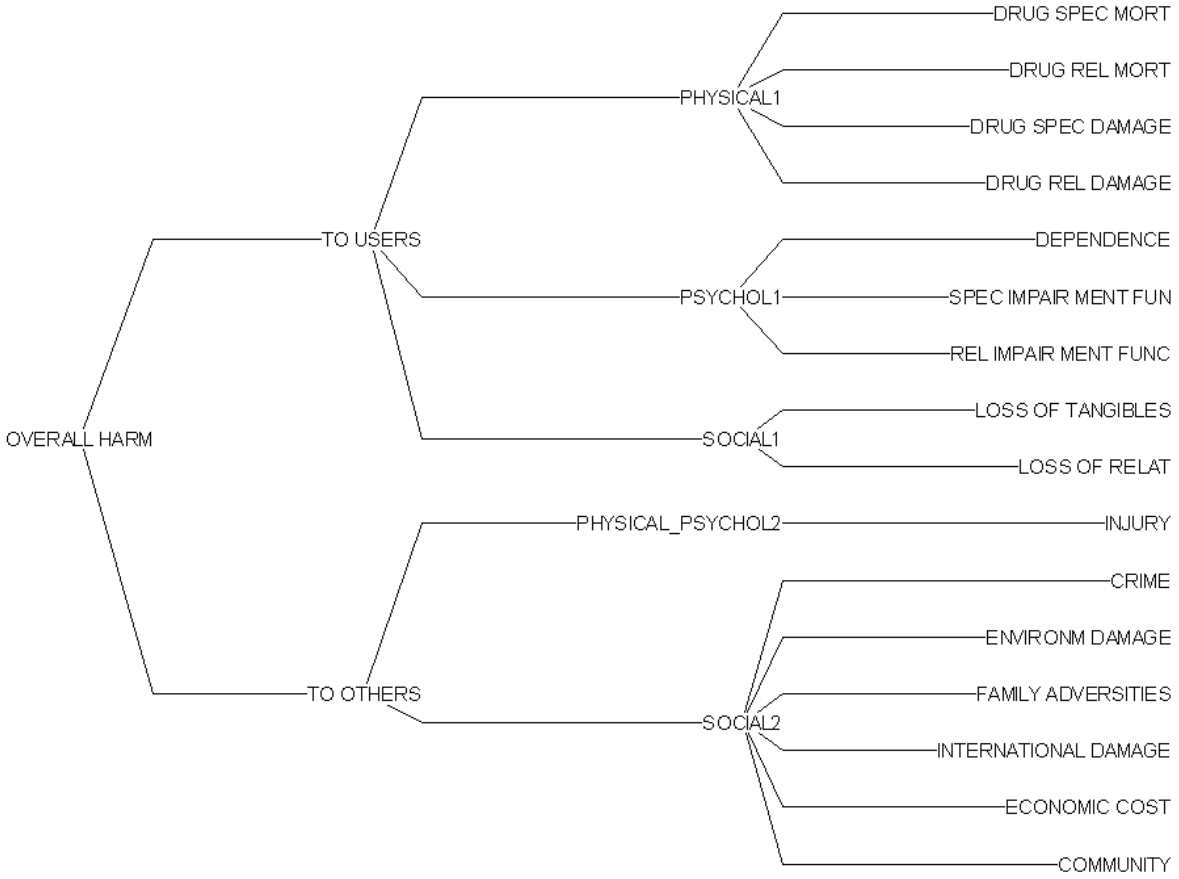

Figure 1. The evaluation criteria organised by harms to users and harms to others, and clustered under physical, psychological and social effects.[2]

[2] See Table 1 for full criteria titles.

Table 1: Definitions of the evaluation criteria.

Short Name	Description
	HARM TO USER:
DRUG SPECIFIC MORTALITY	Intrinsic lethality of the drug expressed as ratio of lethal dose and standard dose (for adults). 100 = an inverted ratio of 33% (ratio of 3 --> 1/3) 50 = an inverted ratio of 10% (ratio of 10 --> 1/10) 0 = an inverted ratio of 0%
DRUG RELATED MORTALITY	The extent to which life is shortened by the use of this drug (excludes drug specific mortality), e.g. road traffic accidents, lung cancers, blood borne viruses (BBV), suicide.
DRUG SPECIFIC DAMAGE	Drug specific damage to physical health, e.g. cirrhosis, seizures, strokes, cardiomyopathy, stomach ulcers.
DRUG RELATED DAMAGE	Drug related damage to physical health, including consequences of e.g. unwanted sexual activities and self-harm, BBV, emphysema, damage from cutting agents.
DEPENDENCE	The extent to which this drug creates a propensity or urge to continue to use despite adverse consequences (ICD10 or DSM4).
SPECIFIC IMPAIRMENT FUNCTION	Drug specific impairment of mental functioning, e.g. amphetamine induced psychosis, intoxication.
RELATIVE IMPAIRMENT FUNCTION	Drug related impairment of mental functioning, e.g. mood disorders secondary to drug-users lifestyle or drug use.
LOSS OF TANGIBLES	Loss of tangible things, e.g., income, housing, job, educational achievements, criminal record, imprisonment.
LOSS OF RELATIONSHIPS	Loss of relationship with family and friends.
	HARM TO OTHERS:
INJURY	The extent to which this drug increases the chance of injuries to others both directly and indirectly, e.g. violence (including domestic violence), traffic accident, foetal harm, drug waste, secondary transmission of BBV.
CRIME	The extent to which the use of this drug involves or leads to an increase in volume of acquisitive crime (beyond the possession or supply of the drug) directly or indirectly (at the population level, not the individual) 100 = the most harmful (on a relative scale), 0 = no harm.
ENVIRONMENTAL DAMAGE	The extent to which the use and production of this drug causes environmental damage locally, e.g. toxic waste from amphetamine factories, discarded needles.
FAMILY ADVERSITIES	The extent to which the use of this drug causes family adversities, e.g. family breakdown, economic well-being, emotional well-being, future prospects of children, child neglect.
INTERNATIONAL DAMAGE	The extent to which the use of this drug causes damage at an international level, e.g. deforestation, destabilisation of countries, international crime and new markets.
ECONOMIC COST	The extent to which the use of this drug causes direct costs to the Country (e.g. healthcare, police, prisons, social services, customs, insurance, crime) and indirect cost (e.g. loss of productivity, absenteeism).
COMMUNITY	The extent to which the use of this drug creates decline in social cohesion and decline in the reputation of the community.

To be useful and satisfy the theoretical requirements of MCDA, criteria are subject to certain constraints, which ensure that the calculated weighted averages are meaningful. The requirements are that the criteria should be: (1) complete in covering all the important aspects of harm (2) non-redundant in that they distinguish between drugs and do not include any unnecessary criteria (3) operational so the options can be judged against the criteria as more or less preferred (4) mutually preference independent so that in scoring the drugs on one criterion it is not necessary to know the scores on any other criterion (5) unique, so there is no double-counting (6) requisite number, neither too many criteria nor too few, and (6) accommodating of performance over time (Belton *et al*, 2002). With input from the facilitators these constraints were met.

Assessing drugs

For each criterion a given drug would be scored using points out of 100, with 100 assigned to the most harmful drug on the criterion and zero meaning 'no harm'. Weighting subsequently compares the drugs scored 100 across all the criteria, thereby expressing the judgement that those drugs scored 100 are more harmful than others.

In scaling the drugs, care is required to ensure that each successive point on the scale represents equal increments of harm. Thus, if a drug is scored 50 for a particular criterion, then it should be half as harmful as the drug scored 100 on that criterion. Because zero represents no harm, this scale can be considered a ratio scale, which facilitates interpretation of combined scales.

The proposed scale for drug specific mortality is defined in terms of the ratio of a lethal dose to a standard dose, which leads to no upper limit for drugs that are not lethal. However, by inverting the ratio, this problem is overcome, as shown in the first row of Table 1: a score of 0 is given to the new ratio of zero, a score of 50 to a ratio of 1/10, and a score of 100 to a ratio of 1/3. However, this is clearly a non-linear scale, and might be the subject of further consideration.

The scores derived from this part of the process are the first set of value judgements that are expressed in MCDA. Even if harm is measured objectively, it would still be necessary to convert the metric into a preference value scale, indicating how harm is a function of the measured quantity, called a 'value function' in MCDA. For example, using the first criterion, doubling the metric might be interpreted as quadrupling the harm. That non-linear relationship is evident in the definition given here. Doubling the score from 5 to 10 implies that harm increases from 1/10 to 1/3, a ratio of 3.33 to 1. Alternatively, the difference between 10 and 5, 1/3 – 1/10, compared to the difference between 5 and 0, 1/10 – 0, is in the ratio of 2.33 to 1. Either way, harm increases more from 5 to 10 than it does from 0 to 5. This is clearly a value judgement.

Consistency checking is an essential part of proper scoring, as it helps to minimise bias in the scores, and encourages realism in scoring. It is important that the underpinning evidence is considered as scores can, and should, change according to changes in the evidence. In addition, it is important to look at the relativities of the scores, within a given criterion, to see if they, relatively, are right.

Swing weighting

Once scored, the criteria are weighted. The purpose of weighting is to ensure that the units of harm on the different preference scales can be compared and combined across criteria. To ensure that assessed weights are meaningful, swing weighting is used. Some criteria are more important expressions of harm than others. Although that is an intuitively appealing statement, more precision is needed to enable the assessment of weights to the criteria. This is accomplished with the concept of 'swing weighting'. As an analogy, both Fahrenheit and Celsius scales contain 0 to 100 portions, but the swing in temperature from 0 to 100 on the Fahrenheit scale is, of course, a smaller swing in temperature than 0 to 100 on a Celsius scale; it takes 5 Celsius units to equal 9 Fahrenheit units. The purpose of weighting in MCDA is to ensure that the units of harm on the different preference scales are equivalent, thus enabling weighted scores to be compared and combined across the criteria. Weights are, in essence, scale factors. Thus, MCDA does not directly compare different kinds of harms, it compares the *preference values* associated with the harms. The common unit is preference value, just as money is the common unit in cost-benefit analysis.

To assess these scale factors, the meaningful question to answer is this: "How much do you care about the added harm represented by a swing from a preference value of 0 to a preference value of 100 on this criterion compared to the 0-to-100 swing on another, specified, criterion?" It is the combination of the 0-to-100 difference in preference values, and how much the assessor cares about them that defines an increment in value. In MCDA, the scales that are compared are value scales, not harm scales. The distinction is important. On the one hand, harm expresses a level of damage. Value, on the other hand, indicates how much that level of damage matters in a particular context. And because context can affect assessments of value, it is likely that one set of criterion weights for a particular context may not be satisfactory for decision making in another context.

It follows, then, that to judge the value of a drug's harm, two steps in thinking must be separated. First, it is necessary to think about the added harm going from no harm at all to the level of harm represented by a score of 100. That is a straightforward assessment of a difference in harm, from no harm to the harm associated with the worst drug on that criterion. The next step is to think about how much that difference in harm matters in a given context. "How big is the difference in harm and how much do you care about that difference?" This is the question that is posed in comparing the 0-to-100 swing in harm on one scale with the 0-to-100 swing on another scale.

To start the process, one needs to assess the weights within each grouping of criteria, then across the groupings. For instance, in starting with the physical harm to users grouping, there are four criteria. Assessors would compare the swing in harm from those adjudged to be least harmful to most harmful in one criterion. This is done by first considering the differences in actual harm and second, judging how much that difference matters. Then, in a similar way the first swing would be compared to the swing on the third criterion and so on. As a result of paired-comparisons, an arbitrary swing weight of 100 can be assigned to the criterion adjudged most harmful. This is then continued at each first node of Figure 1.

The same process as above is then applied to assessing the relative weights for the three criteria under the psychological harm grouping, and assigning the biggest of the three swings a weight of 100. It should be noted that assigning 100 to one scale in this grouping does not necessarily represent the same level of harm as the 100 in the previous grouping, just as 100 degrees Fahrenheit does not mean the same temperature as 100 degrees Celsius.

In the next part of the process it is necessary for users to equate scales given weights of 100, one from each node. First, the one criterion that was given a weight of 100 in each of the three groupings under TO USERS is considered and displayed for each of those three scales. The judgements of weight would now be more difficult to make as they require comparisons of physical, psychological and social harm. However, the group which users agree matters most retains the score of 100 on that scale, and the other 100-weighted criteria are then compared to that one.

Finally, the single most harmful swings under TO USERS and under TO OTHERS would be compared, completing the weighting process. At this point the units of harm on all scales would be equivalent, enabling the harm scores to be combined within any grouping simply by adding the weighted scores.

To ensure that final results are displayed on a 0 to 100 scale, the Hiview programme normalises the weights at each node, retaining the ratios of weights to each other, but ensuring the normalised weights sum to one. This normalisation process is carried out over the entire value tree; it does not, of course, have any influence on the relative results at any node, or on the final overall ordering.

5. Results

Overall

With scoring completed accurately and weighting determined it would be possible to calculate sums of weighted scores and show results at any node. One way to do this is to display the overall weighted score of each drug as a bar graph. Stacked bar graphs could show the contribution of harm to users and harm to others in different colours, or could show the extent to which each criterion contributes to the overall result for each drug.

Results can also be separated out in an X-Y plot to show, for example, harm to users on one axis and harm to others on the other axis so the relative contributions of those types of harm can be considered independently of the relative weights on those two types of harm.

Sensitivity Analyses

These analyses explore the sensitivity of the overall results to changes in weights on the criteria. This is where different options can be explored, for instance, some users of the model may make different judgements on the weightings depending on their objectives for using the model. This is important to explore as it provides transparency to the value judgements that any group may place on each of the criteria in the overall assessment of relative harm.

Sensitivity analyses can also be conducted at nodes, showing the overall results as the weight on the node is changed.

Comparative Analyses

Comparative analyses can be used to explore, for example, why a drug is judged to be most harmful on a criterion-by-criterion basis. This can be viewed as a relative contribution to the overall harm score, a different kind of display from the stacked bar graph. An instructive comparative analysis compares any drug with any other drug, which highlights with a simple graphical display the important ways in which one drug differs in its harm from another drug.

6. Discussion and Conclusion

The model that the ACMD explored in this paper looks to demonstrate a proof of concept of the use of such frameworks in the decision making process. The model provides a conceptual, structured framework for the consideration of the harm of a given drug.

The model is, necessarily, a draft and has not yet had the external scrutiny required for the development of rigour; full validation of the model is required to test its underlying assumptions. This process would include the input of datasets and the gathering of evidence that is needed to underpin the judgements and preferences. However, the model is presented as a potential tool for developing contributions to the decision making process that are credible and consistent.

The approach presented facilitates a transparent and consistent method for considering the evidence and the gaps for new drugs of use. The framework builds on the work of Nutt *et al* (2007) and the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA, 2009) by providing a more complete set of criteria, a scoring system that is more sensitive to differences than the rating scales typical of non-MCDA-based approaches, and a method for weighting criteria according to their relative importance (or 'preference').

Using such a model has the advantages of being able to consider all the harms of a substance objectively and comparably with others, enables harms to be weighted according 'values', and being able to compare a drug that is very harmful but rarely used to a less harmful drug used by many, which has been a particular challenge to the ACMD in recent years. The model is developed so that the degree of individual harm is considered in the criteria under TO USERS, while many of the criteria under TO OTHERS accommodate the numbers of users harmed.

A number of issues arose in the ACMD's consideration of employing the model in the development of its advice. For example, unequivocal data about substances on all the 16 criteria will never be wholly adequate. Thus, there is further discussion to be had about how to manage the model when there is insufficient evidence to score some of the criteria. Structured expert judgement will always be required in such cases, which can be supported by sensitivity analysis of the model's outputs. This is currently very topical given the current rise in prevalence of new synthetic psychoactive substances (e.g. those substances known as 'legal highs') and the paucity of data available.

Further refinement could also be made to the criteria; particularly clarification should be given for whether a substance is assessed from a 'user' or 'abuser' perspective as this could significantly effect the scoring of some of the criteria. For example, some users of a substance, may manage their use in a way that causes minimal harm to themselves and others, whereas others may abuse the substance such that their use causes significant harm to themselves and others. The tendency of a substance to lead to abuse is included in the model through the criterion of dependency.

The model has not been developed to take into account an assessment of 'poly-drug use[3]' and the consequent increased potential for harm. This is currently an area of consideration by the ACMD, but how it might be incorporated into the model needs further consideration.

The ACMD recognise that further development is required of the model, in particular: the implementation of the model's criteria to improve the validity of input data; the development of value functions to convert the metrics into preference values; and the exploration of how different contexts (e.g. investment decisions, public health campaigns, law enforcement) and constituencies who might weight the criteria differently.

The ultimate purpose of a fully developed model would be to seek to improve the transparency of policy recommendations for decision makers in the drugs field and to facilitate communication with the public. Such a model would allow adviserrs to explore considerations for policy recommendations and provide a mechanism for examining how different public perceptions of risks associated with psychoactive substances could affect policy-making. Sensitivity analyses provide the means to see how the relative ranking of harm might change under different scenarios, enabling advisors and decision makers to develop strategies that would be robust to these different perceptions.

Although the MCDA model remains largely subjective, it offers a framework on the harms associated with substances rather than providing definitive answers. It may be that it provides a mechanism for combining many sources of information, along with their expert judgements, in such a way that the very best independent expert advice can be formulated expeditiously in response to new information and changing social conditions.

The ACMD recognises the need for further, external, development of the model and for research that can test the underlying assumptions. The ACMD welcomes such further research on this initial study to consider the next steps on how best to employ such tools in the context of providing advice.

[3] Poly-drug use' is considered to be the simultaneous use of more than one drug.

7. Acknowledgements

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Appendix. Members of the Advisory Council on the Misuse of Drugs

Member	Sector
Professor Leslie Iversen (ACMD Chair)	Professor of Pharmacology, Oxford University
Dr Dima Abdulrahim	Briefings Manager, National Treatment Agency
Lord Victor Adebowale	Chief Executive, Turning Point
Dr Jason Aldiss	Veterinary Medicine and Public Health - Managing Director of Eville & Jones Ltd
Mrs Gillian Arr-Jones	Chief Pharmacist for the Care Quality Commission
Mr Martin Barnes	Chief Executive, Drugscope
Dr Margaret Birtwistle	Specialist General Practitioner, Senior Tutor – Education and Training Unit, St George's Hospital and Forensic Medical Examiner
Commander Simon Bray	Commander, Metropolitan Police Service
Dr Roger Brimblecombe	Pharmaceutical Industry - Pharmacologist
Ms Carmel Clancy	Principal Lecturer for Mental Health and Addiction, Middlesex University
Professor Ilana Crome	Professor of Addiction Psychiatry, Keele University
Ms Robyn Doran	Mental Health Nurse and Director of Operations, North-West London Mental Health Trust
Professor Simon Gibbons	Professor of Phytochemistry (natural product chemistry), School of Pharmacy, University of London
Mr Patrick Hargreaves	Adviser for Drugs and Alcohol, Durham County Council Education Department
Ms Caroline Healy	Children's Strategic Adviser
Professor Raymond Hill	Professor of Pharmocology, Imperial College London
Mr David Liddell	Director, Scottish Drugs Forum

Mr Hew Mathewson CBE	Dentist and former President and Chair of the General Dental Council (2002 to 2009)
Dr Fiona Measham	Senior Lecturer in Criminology, University of Lancaster
Mr Graham Parsons	Pharmacist with Special Interest (Substance Misuse), NHS Plymouth
Mr Trevor Pearce	Director of Enforcement, Serious Organised Crime Agency
District Judge Justin Phillips	District Judge, Drugs Court London
Mr Richard Phillips	Independent Consultant, Phoenix Futures
DCC Howard Roberts	Retired Police Officer
Dr Mary Rowlands	Consultant Psychiatrist in Substance Misuse, Exeter
Ms Monique Tomlinson	Freelance Consultant in Drugs Misuse
Mr Arthur Wing	Director, Surrey and Sussex Probation Trust