# Appendix 7 – Health economics technical details

**This Appendix comprises the health economics technical details from the Methods section.**

## Within study data measurement and valuation

### Health service use

GP and nurse visits

Data (self-reported) for GP and nurse visits were extracted from the staff and PiC surveys for all three phases to calculate monthly resource use. Staff were asked ‘In the last 3 months how many times did you visit your GP because you had a cold, breathing problems or eye irritation?’ For PiC, ‘GP’ was replaced with ‘doctor or nurse’.

Outpatient, Inpatient, Mental Health and Accident & Emergency visits (PiC)

Routine health data were sourced for PiC only from NHS National Services Scotland (NHS NSS) from the following datasets:

* SMR00 (outpatient attendance) – number of attendances
* SMR01 (acute hospital admissions) - inpatient length of stay
* SMR04 (psychiatric hospital admissions) - mental health length of stay
* A&E2 (accident and emergency attendance) - number of attendances

The Community Health Index (CHI) is a unique identifier for each individual in Scotland and is collected in most health care. Due to time constraints and the complexity of linking individual level data, other methods of identifying health care resource use by PiC were investigated. These are explained for each dataset below; it was not possible to identify and exclude resource use at the open prison for any of these datasets. All data received covered the period 1 June 2016 to 30 November 2019.

*Outpatient attendances*

Total outpatient attendances were identified using two variables in the SMR00 dataset: 1) ‘GP practice code’; and 2) ‘Referral source code’. Data identified via at least one of these methods were included in the analysis. Data were received as aggregate monthly attendances.

*Inpatient length of stay*

Two variables in the SMR01 dataset were used to identify inpatient length of stay: 1) ‘GP practice code’; and 2) ‘admission/transfer from’. Data identified via at least one of these methods were included in the analysis. Length of stay is number of days between date of admission and date of discharge, by speciality, and was received in an aggregate monthly format.

*Mental health length of stay*

We used the same identification methods for SMR04 as for SMR01 (above). Length of stay is again number of days between date of admission and discharge, by mental health speciality and was received in an aggregate monthly format. Exploration of the mental health data identified extremely long length of stays for the forensic psychiatry specialty which dominated the results impeding understanding in and interpretation. ISD and a forensic psychiatrist were consulted to better understand the forensic psychiatry results, following these consultations it was decided to exclude the forensic psychiatry stays from the analyses for the following reasons:

* There is no robust mechanism by which introducing a smoke-free policy would change forensic psychiatry stays, it is not believed to be a potential indicator of mental health impacts of the smoke-free policy (unlike depression, anxiety, self-harm for example).
* The length of stay for forensic psychiatry is often dictated by legal process rather than clinical need so is unlikely to change as a result of the smoke-free policy.
* Approximately one third of admissions to forensic psychiatry are directly from courts, making the ‘legal establishment’ method of identifying PiC stays less reliable.

*Accident and emergency attendances*

The number of aggregate monthly accident and emergency attendances were identified using the ‘postcode of residence’ field.

Ambulance data

The number of incidents involving an emergency ambulance use (1 June 2016 to 30 November 2019) were provided by SPS as an aggregate monthly number.

Medication dispensing

Medication dispensed to PiC was taken from the national pharmacy contract data held by National Procurement, NHS NSS (1 June 2016 to 30 November 2019). Costs were included in the dataset and extracted as an aggregate monthly cost. Further details are available elsewhere(1). The base-case analysis includes two medication types: indicators of treatment for nicotine dependence; and indicators for treatment of smoking-related illnesses or associated symptoms.

### Nicotine products

Tobacco (staff)

Weekly tobacco spend was estimated from TIPs staff survey responses for each Phase. The weekly spend was assumed to be consistent across the time period of each phase and monthly usage was estimated for each phase.

Tobacco and NVP (PiC)

PiC’s purchases of tobacco and NVP were extracted as an aggregate monthly spend from SPS canteen data (Best et al, personal communication). Canteen data had been provided by SPS for a complementary CRUK-funded study (see *Figure 1*) and include PiC’s purchases from 29 July 2018 (three months prior to policy implementation) to November 2018 for tobacco and to November 2019 for NVP. We were unable to access data for tobacco products before 29 July 2018; however, analysis showed amount of spend on all tobacco-related products prior to policy implementation was consistent month to month (Best et al, personal communication). We therefore applied the assumption that tobacco-related product spend was constant between June 2016 and July 2018. Aggregate monthly mean spend for this earlier period was based on three months’ data: August, September and October. NVP were included on the canteen list from September 2018 so relevant data were available over the study period. Canteen data from Scotland’s two privately run prisons were not available.

Resource use sources and availability is summarised in the Table below: **‘Resource use data sources and time period available’)**.

**Table 2-8-1: Resource use data sources and time period available**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Resource use** | **Source** | **Period data covers** | **Frequency** | **Data format** |
| **Health** |  |  |
| Staff |  |  |
| GP visits (staff) | Survey - phase 1, 2 & 3 number of visits in previous 12 months | All 3 phases | 3 timepoints; Phase 1, 2 & 3 | From individuals, (mean, sd n) |
| People in custody |  |  |
| GP/nurse visits | Survey - phase 1, 2 & 3 number of visits in previous 3 months | All 3 phases | 3 timepoints; Phase 1, 2 & 3 | From individuals, (mean, sd n) |
| Outpatients  | ISD SMR00 | Jun 2016 -Nov 2019 | Monthly | Aggregate data for all PiC, (total monthly count) |
| Inpatient stays | ISD SMR01 | June 2016 to Nov 2019 | Monthly | Aggregate data for all PiC, (total monthly count – admissions and los) |
| Mental health stays | ISD SMR04 | June 2016 to Nov 2019 | Monthly | Aggregate data for all PiC, (total monthly count – admissions and los) |
| A&E | ISD Unscheduled Care A&E2 | June 2016 to Nov 2019 | Monthly | Aggregate data for all PiC, (total monthly count) |
| Ambulance | Scottish Prison Service | June 2016 to Nov 2019 | Monthly | Aggregate data for all PiC, (total monthly count) |
| Medication | Prison prescription data  | June 2016 to Nov 2019 | Weekly | Aggregate data for all PiC, (total monthly count) |
| Personal |  |  |
| Staff |  |  |
| Cigarettes  | Survey - phase 1, 2 & 3, how many cigarettes per day  | All 3 phases | 3 timepoints; Phase 1, 2 & 3 | From individuals, (mean, sd n) |
| People in custody |  |  |
| Cigarettes | SPS canteen data  | 3 months prior to ban | Monthly | Aggregate data for all PiC (total resource use and spend)  |
| Nicotine vaping products | SPS canteen data  | 3 months prior to ban, onwards | Monthly | Aggregate data for all PiC (total resource use and spend) |

los; length of stay, PiC; people in custody

### Unit costs are presented in (Table below ‘Unit costs and sources’)

*Table 2-8-2: Unit costs and sources*

|  |  |  |
| --- | --- | --- |
| **Resource use** | **Unit cost** | **Source** |
| **Health** |
| Staff |
| GP visits (staff | £31.30 | PSSRU 2017/18 |
| People in custody |
| GP/nurse visits | £20.30 | PSSRU 2017/18 GP and nurse, length of consultation from PSSRU 2015 |
| Outpatients  | £176.00 | ISD cost book 2017/18 R044X, consultant led new patient, cost per attendance |
| **Inpatient stays** |
| Mean across all specialities | £1,190.00 | ISD cost book 2017/18 R040, cost per bed day |
| Accident & Emergency | £1,492.34 |
| Cardiac Surgery | £2,042.72 |
| Cardiology | £720.16 |
| Clinical Oncology | £1,009.80 |
| Dermatology | £514.63 |
| Ear, Nose & Throat | £1,290.04 |
| Gastroenterology | £554.54 |
| General Medicine | £482.35 |
| General Surgery (exc Vascular Surgery) | £865.83 |
| Gynaecology | £1,543.31 |
| Haematology | £1,097.21 |
| Intensive Care Unit | £2,217.48 |
| Medical Oncology | £1,286.00 |
| Neurology | £1,128.05 |
| Neurosurgery | £1,439.17 |
| Ophthalmology | £1,596.58 |
| Plastic Surgery & Burns | £1,705.61 |
| Respiratory Medicine | £510.46 |
| Thoracic Surgery | £1,359.73 |
| Urology | £938.50 |
| Vascular Surgery | £652.04 |
| General Psychiatry | £3,645 | ISD cost book R040LS, cost per inpatient week |
| Geriatric Psychiatry | £2,669 |
| Learning Disabilities | £4,833 |
| Adolescent Psychiatry | £6,158 |
| Child and Adolescent Psychiatry | £6,158 | No cost for this, only for child or adolescent – assume most inpatients are adolescents and apply this cost (as above) |
|  |
| A&E | £137 | ISD cost book 2017/18, R044 cost per attendance |
| Ambulance | £310 | ISD cost book R910 2017/18 cost per incident (accident & emergency, All Scotland) |
| Medication | Various | Taken from National Procurement dataset |
| **Personal** |
| Staff |
| Cigarettes  | £10.23 for 20 king size | ONS |
| People in custody |
| Cigarettes | Various | Taken from canteen data |
| E-cigs/vapes | Various | Taken from canteen data |

## Within study outcomes

### Outcomes

Several health and organisational outcomes were included in the analyses, sourced from TIPs study data and SPS (Next table *Outcomes, ‘their sources and period data covers’)*

SHS

The primary outcome derived from the TIPs study was SHS levels, using PM2.5 measurements (see *2.3* and(2-4)). Outcomes used in this analysis include fixed-site monitoring measurements only, at all three measurement points (November 2016, 28-30 November 2018 (pre-policy implementation) and May 2019 (post-implementation). (2)

Health related quality of life (HRQOL)

We collected data on HRQOL using responses to the EQ-5D-5L questionnaire(5) included in TIPs staff and PiC surveys at each of the three study Phases. The EQ-5D includes five questions on mobility, self-care, usual activities, pain/discomfort and anxiety/depression (response range: ‘no problem’ to ‘unable to walk/wash/do usual activities’ etc.). Answers were converted to health utilities by mapping to the EQ-5D-3L value set, as recommended by NICE(6).

Violence related incidents

The monthly number of violence related incidents (November 2017 to November 2019) were provided by SPS in anonymised form as ‘prisoner on prisoner’ and ‘prisoner on staff’ assaults.

Deaths in custody

The monthly number of all cause deaths in custody were provided by SPS in anonymised form.

Fires

Monthly number of fires were provided by SPS; it was possible to identify and exclude open prison data.

Management of offenders at risk due to any substances (MoRs)

The monthly number of PiC managed under the MoRs policy were provided by SPS in anonymised form. The purpose of the MoRs policy is to ensure that PiC are appropriately cared for and is implemented when PiC are suspected of being at risk of substance misuse.

**Table2-8-3***Outcomes, their sources and period data covers*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Outcomes** | **Source** | **Time period** | **Frequency** | **Data format** |
| Levels of SHS | TIPS measurements  | Nov 2016/28– 30 Nov 2018/May 2019 | 3 timepoints; Phase 1, 2 & 3 | From individual prisons (mean, SD n) |
| Utilities | TIPS staff and prisoner surveys  | Whole study | 3 timepoints; Phase 1, 2 & 3 | From individuals, (mean, sd n) |
| Violent related incidents: Prisoner on prisoner | SPS  | November 2017 to November 2019 | Monthly | Aggregate data for all PiC (total count) |
| Violent related incidents: Prisoner on staff | SPS | November 2017 to November 2019 | Monthly | Aggregate data for all PiC (total count) |
| All cause people dying in custody | SPS | June 2016 to November 2019 | Monthly | Aggregate data for all PiC (total count) |
| Fires | SPS  | June 2016 to November 2019 | Monthly | Aggregate data for all PiC (total count) |
| Management of offenders at risk due to any substances (MoRs) | SPS  | June 2016 to November 2019 | Monthly | Aggregate data for all PiC (total count) |

## Analysis

Where possible data from the open prison was excluded, a sensitivity analysis included open prison data, details of which variables open prison data was excluded in are in TABLE ‘*Inclusion and exclusion of data from the open prison’*

**Table2-8-4:** *Inclusion and exclusion of data from the open prison*

|  |  |  |
| --- | --- | --- |
| **Resource/Outcome** | **Open prison data can be excluded** | **Open prison data always included** |
| GP - staff |  | ✓ |
| GP/nurse - PiC | ✓ |  |
| SMR00, SMR01 & SMR 04 |  | ✓ |
| Ambulance | ✓ |  |
| A&E  |  | ✓ |
| Medication  | ✓ |  |
| Staff tobacco |  | ✓ |
| Pic tobacco and NVP | ✓ |  |
| SHS |  | ✓ |
| QALYs - staff |  | ✓ |
| QALYs - PiC | ✓ |  |
| Violence | ✓ |  |
| Deaths |  | ✓ |
| Fires | ✓ |  |
| MoRs | ✓ |  |

## Long-term model transitions

### Model transitions (Parameters are provided in Table ‘*Parameters used in long-term model’*

Smoking status/prevalence

Staff and PiC enter the model as a ‘tobacco smoker’, ‘quit/tobacco abstinent’ or a ‘non-tobacco smoker’. The proportions of each cohort assigned to each state in the ‘in prison’ period are estimated as follows:

* **Staff** – the prevalence of tobacco smoking, taken from the Scottish Health Survey 2017(7), is available and applied separately for men and women.
* **PiC** – the prevalence of tobacco smoking is taken from 16th Prisoner Survey 2017(8), available and applied for the general prison population.

In the ‘without the smoke-free policy’ comparator, staff and PiC transitioning from the ‘in prison’ to ‘post-prison’ period are assumed to retain the smoking status they have in the previous cycle in the ‘in prison’ period. In the ‘with smoke-free policy’ comparator, we assume staff retain the same smoking status they have in the ‘in prison’ period, and 100% of PiC who were ‘quit/forced abstinent’ in the ‘in prison’ period are conservatively assumed to resume smoking on entering the ‘post-prison’ state. As there is little evidence on smoking resumption rates on leaving a smoke-free prison, we explore the effect of this assumption in two scenario analyses.

To account for staff and PiC who may quit smoking in the model, not related to the smoke-free policy, we have applied a population background quit rate. In the ‘without the smoke-free policy’ comparator, this is applied to both cohorts in both periods. In the ‘with the smoke-free policy’ comparator, this quit rate is applied to both cohorts in the ‘post-prison’ period; in the ‘in-prison’ period it is applied in the same way to staff, but for PiC we separately calculate the number of people who would have quit each cycle and the total of these remain in the ‘quit/tobacco abstinent’ state when transitioning to the ‘post-prison’ period.(9)

Smoking related morbidity

Four smoking related diseases were included in the model: coronary heart disease (CHD), chronic obstructive pulmonary disease (COPD), lung cancer and stroke. These smoking-related diseases(10) account for ~75% of smoking-related deaths.(11)

The prevalence of smoking-related diseases were available for male and female never, former and current smokers at a given age(12) and applied to the states in the model. These were estimated using the prevalence of morbidity (irrespective of smoking behaviour at all ages for male and female), the prevalence of different smoking behaviours at all ages for male and female and relative risks for each morbidity associated with current- and former-smoker status at all ages for male and female (never smokers are assumed to have a relative risk of 1). Given a lack of evidence to support any alternative assumptions, the prevalence of each disease is assumed to be independent of each other.

There is sufficient evidence of causality between SHS exposure and CHD and lung cancer prevalence in never-smokers.(13) In the model non-tobacco smoking staff and PiC are assumed to be exposed to SHS in the ‘in prison’ period in the ‘without the smoke-free policy’ comparator. To account for this we applied associated relative risks for CHD and lung cancer to never-smoker morbidity prevalence rates for ‘non-tobacco smokers’ in the ‘in prison’ period.

The effect of SHS exposure is only applied to ‘non-tobacco smokers’ for two reasons: 1) current and former-smokers are not assumed to be immune from the effects of SHS; the direct effects on health of smoking conceal the more subtle effects of SHS exposure on health, and 2) evidence of SHS exposure on morbidity is mainly based on research reporting effects on never-smokers.

Mortality

Mortality in the model was based on smoking status, age and sex, and estimated separately for staff and PiC:

* ***Staff*** – Mortality rates were estimated using 2018 long-term mortality rates from National Records of Scotland(14) data, stratified by age for males and females. These were then adjusted using the increased risk of death for smokers and former-smokers taken from Doll et al,(15) chosen for its large sample size (n=34,439) and 40-year follow-up. Prevalence of smoking by age and gender was taken from the Scottish Health Survey 2017.(7)
* ***PiC*** –Research suggests PiC experience a lower mortality rate whilst in prison and an increased mortality rate on release from prison.(16-18) To account for this in the model, the SMRs reported in research into mortality for a cohort of PiC who were imprisoned for the first time between 1996 and 2007(16) was applied to the mortality rates estimated for staff to represent PiC mortality. The effects of these SMRs on model results was explored in a scenario analysis.
* ***SHS*** - To account for the effect of SHS exposure on mortality, ‘never-smoker’ mortality was adjusted as it is estimated that SHS exposure accounts for 1% of overall global mortality.(13, 19) In the model, mortality for ‘non-tobacco smoking’ staff and PiC not exposed to SHS was reduced by 1%; this related to all ‘post-prison’ time periods, and for the ‘in prison’ period, post-policy implementation.

### Parameters

Resource use and costs

Evidence on resource use and costs are sourced from SPS freedom of information, literature and TIPs data. Whereas resource use in the within study analysis was at a granular level, resource use in the model takes a more high level approach. Resource use comprises intervention, health care use and personal use of tobacco and NVP.

Intervention

Intervention costs are only applied in with the ‘with smoke-free policy’ comparator. These comprise the costs to SPS of providing vaping kits to PiC;(20) the cost of one kit is applied to each PiC irrespective of smoking status. This is a conservative approach as we do not know the smoking status of PiC immediately before they come into prison, only once they are in prison.

Health care

Health care use comprises costs applied to the smoking-related morbidities mentioned in the *Model* *Transitions* section above. Treatment costs are sourced from literature(21) and inflated to 2017/18 prices.(22) The annual healthcare cost associated with each morbidity is applied to the number of people with each co-morbidity every cycle.

Personal

For staff the annual personal cost of tobacco was estimated based on reported number of cigarettes smoked per working and non-working day by operational staff in the TIPs staff questionnaires, assuming consistent daily usage throughout the year. The number of cigarettes reported as smoked in the Phase 1 questionnaires was used for the ‘without smoke-free policy’ comparator, and responses to Phase 3 questionnaires for the ‘with smoke-free policy’ comparator. The mean price of 20 king size filter cigarettes (according to Office of National Statistics(22)) was applied to the number of cigarettes smoked to estimate a mean spend per annum with and without the smoke-free policy. As no data were available for staff personal spend on NVP, these were not included in the model.

Personal costs of tobacco and e-cigarettes for PiC were sourced from analyses of canteen data, conducted in the complementary CRUK-funded e-cigarettes in prison study:

* Mean weekly spend on tobacco by smokers was available for the period 29 July 2018 to 1 October 2018. We assumed these costs were consistent throughout the year and calculated an annual cost. This was applied to PiC in the ‘tobacco-smoking’ state, ‘in prison’ ‘without the smoke-free policy’. No tobacco costs were applied to PiC in the ‘in prison’ period in the ‘with smoke-free policy’ comparator. As we do not have any information on tobacco spend or the number of cigarettes smoked outside prison, we applied the ONS cost to the mean number of cigarettes reported as smoked in the TIPs prisoner questionnaire in Phase 1. We explored the effects of this assumption on results in a scenario analysis.
* Mean weekly e-cigarette costs were available for the period 1 February 2019 to 25 November 2019. We assumed these costs were consistent throughout the year and calculated an annual cost. This was applied to all former smokers in the ‘in prison’ period in the without the smoke-free policy comparator. As we have no information on how many PiC use NVP after release, no NVP costs are applied ‘post-prison’.

We explored the effect of using canteen costs on the ICER in a scenario analysis.

Outcomes

The outcome of the model is the QALY, a combination of length and quality of life, where quality of life is measured using health utilities. Health utilities were sourced from Maheswaran et al.,(23) which were estimated from the 2008 Health Survey for England; complete data were collected for 9,551 participants over 16 years in the general population using the EQ-5D questionnaire. Health utilities were reported according to smoking status: never-smoker, light smoker (<10 cigarettes per day), moderate smoker (10-20 cigarettes per day), heavy smoker (20+ cigarettes per day), and ex-smoker. ‘Non-tobacco smokers’ in the model were assigned the never-smoker health utility.

Staff and PiC tobacco smokers were assigned health utilities according to the mean number of daily cigarettes smoked reported in the TIPs questionnaires:

* The daily mean number of cigarettes for staff who smoked was calculated across the three Phases of TIPs; staff reported a mean of 9.6 cigarettes on a workday and 12.6 on days off, a daily mean of 11.1. Staff tobacco smokers were assumed to be moderate smokers (10-20 cigarettes per day) and assigned the moderate smoker health utility.
* The daily mean number for PiC was calculated from TIPs Phases 1 and 2. As the daily mean was 19.3 with 56% of respondents reporting smoking 20+ cigarettes per day, PiC who were tobacco smokers were assumed to be heavy smokers and assigned the heavy smoker health utility.

Ex-smoker health utilities were assigned to PiC and staff who quit during the model due to the background quit rate, and to PiC who were ‘quit/tobacco abstinent’ in the ‘with smoke-free policy’ comparator.

SHS health utilities to reflect quality-of-life for non-tobacco smoking staff and PiC exposed to SHS in the ‘without a smoke-free policy’ comparator, were based on research showing an association between SHS exposure and a decrease in quality of life, often with a dose response.(24, 25) A decrement of 1.1% was applied to the never-smoker health utility for staff and PiC exposed to SHS.

We explored the effects of using these health utilities on the results in a scenario analysis. Separate health utilities were applied to staff and PiC with smoking related diseases.(26) Smoking-related diseases are associated with reductions in quality of life and best practice is to include smoking-related disease quality of life in economic evaluations of tobacco control policies.(27) As the model is not able to identify which individuals suffer from more than one smoking-related disease, health utility is applied to each comorbidity.

Age of entering model/prison

The average age of prison operational staff starting work, provided by SPS, was 28.2 years (based on the position at 31 March 2020). For PiC, the mean age of first imprisonment taken from Graham et al.(16) is 26.7 (14.1 – 89.9) for men and 27.0 (14.1 – 75.6) for women; mean age of first imprisonment in the model is 27 years.

Length of time in the prisons

For operational staff the mean length of service, 16.2 years (based on the position at 31 March 2020) was provided by SPS.

For PiC, as we do not consider subsequent incarcerations in the model, we estimated the mean sentence during a PiC’s lifetime to be the total of all expected incarcerations. We took the mean length of sentence in Scotland of 318 days in 2017/18, although we note that this figure does not include life sentences(28). During 2017/18, 27 people were sentenced to life in Scotland, all for homicide; information is available for the mean length of time served in England and Wales for a life sentence for homicide (16.5 years).(29) This mean length of time served was applied to the 27 life sentences omitted from the Scottish mean sentence length(16) to estimate a mean of 331 days. Over a 10-year period PiC were sentenced a mean of 2.7 times.(17) This re-imprisonment rate was used to estimate the total mean sentence length for PiC over a lifetime. As data on this parameter are scarce, we also explored different sentence lengths in scenario analyses.

Population cohort numbers

The number of operational staff, 3,244 (based on the position at 31 March 2020), was provided by SPS. The number of PiC in the population cohort was based on the SPS Annual Report and Accounts 2017/18 and 2018/19(30, 31) (32, 33) using the mean daily population.

**Table2-8-4:** *Parameters used in long-term model*

|  |  |  |  |
| --- | --- | --- | --- |
| **Resource** | **Parameter - mean** | **PSA – distribution (alpha, beta)** | **Source** |
| ***Annual costs*** |
| Intervention | £14 per PiC | N/A | BBC FOI(20) |
| Intervention (population level) | £150,000 for whole population | N/A | BBC FOI(20) |
| *Smoking related diseases:* |
| CHDa | £1,958 (SE £195) | Gamma (99.95, 19.59) | Jones et al(12) |
| COPDc | £899 (SE £90) | Gamma (100.07, 8.98) |
| Lung cancer | £10,178 (SE £1,018) | Gamma (100.00, 101.78) |
| Stroke | £4,630 (SE £32) | Gamma (21578.7, 0.215) |
| *Personal:* |
| Mean price of 20 king size filter cigarettes (2018) | £10.23 | N/A | ONS(22)  |
| Staff tobacco (pre-policy) | £2,290 (SE 20.64) | Gamma (12312.9, 0.186) | ONS(22) applied to TIPS staff questionnaire (phase 1)  |
| Staff tobacco post-policy | £2,054 (SE 23.65) | Gamma (7538.7, 0.272) | ONS(22) applied to TIPS staff questionnaire (phase 3)  |
| PiC Tobacco (pre-policy) | £412 (SE 0.665) | Gamma (384014.3, 0.001) | Canteen data  |
| PiC Tobacco (post-policy) | £3,590 (SE 29.80) | Gamma (14511.1, 0.247) | ONS(22) applied to TIPS PiC questionnaire (phase 1)  |
| PiC NVP (post-policy) | £306 (SE 0.399) | Gamma (586379.6, 0.0005) | Canteen data |
| ***Background quit rate*** | 2% | N/A | NICE(9)  |
| ***Utilities:*** |
| Never-smoker | 0.879 (95% CIb 0.874 to 0.883) | Beta (17734.9, 2441.3) | Maheswaran et al(23) |
| Moderate 10-<20/day | 0.828 (95% CI 0.813 to 0.843) | Beta (2012.5, 418.1) |
| Heavy 20+/day | 0.767 (95% CI 0.745 to 0.789) | Beta (1087.2, 330.3) |
| Ex-smoker | 0.818 (95% CI 0.810 to 0.826) | Beta (7309.1, 1626.2) |
| SHS exposed never-smoker | 0.869  | N/A | 1.1% applied to never-smoker utility(23-25)  |
| ***Smoking prevalence:*** |
| Staff - female | 0.16 | N/A | Scottish Health Survey 2017(7) |
| Staff - male | 0.20 | N/A |
| PiC - all | 0.68 | N/A | SPS 16th Prisoner Survey 2017(8)  |
| ***Smoking related morbidity***  | Various depending on disease, age and sex | Lognormal (various depending on disease, age and sex) | Jones et al.(12)  |
| ***Morbidity SHS exposure:*** |  |  |  |
| CHD | 1.27 (1.19-1.36) | Lognormal (lnmeand 0.239, lnsee 0.034) | Öberg et al.(34)  |
| Lung cancer | 1.21 (1.13–1.30) | Lognormal (lnmean 0.191, lnse 0.036) |  |
| ***Mortality:*** |
| Mortality – general population | Various depending on age, sex and smoking status | Lognormal (various depending on disease, age and sex) | National Records of Scotland(14), Doll et al.(15) & Scottish Health Survey 2017(7)  |
| **PiC mortality SMR:** | Graham et al.(16)  |
| In prison - female | 1.9 95% CI 0.9, 3.5 | Lognormal (lnmean 0.642, lnse 0.346) |
| In prison - male | 0.6 95% CI 0.5, 0.7 | Lognormal (lnmean -0.511, lnse 0.086) |
| Out of prison - female | 5.9 95% CI 5.4, 6.5 | Lognormal (lnmean 1.775, lnse 0.0.047) |
| Out of prison -male | 2.5 95% CI 2.4, 2.6 | Lognormal (lnmean 0.916, lnse 0.020) |

aCHD – coronary heart disease; bCI – confidence interval; cCOPD – chronic obstructive pulmonary disease; dlnmean – lognormal of mean; elnse – lognormal of standard error

### Scenario analyses (parameters in Table ‘Scenario analysis parameters’)

Due to the lack of evidence for resumption of smoking following release from a smoke-free prison, two scenarios were explored:

1. Using the results from TIPs PiC questionnaire Phase 1 in response to a question asking current smokers about smoking on release from prison (‘I think I will smoke after release’).
2. Estimating a realistic resumption rate between the optimistic rate in scenario 1 and the 100% rate used in base-case.

In the base-case analysis the overall length of prison stay was three years, but because there is sparse evidence on length of prison stays, the effect of varying length of prison stay was explored:

1. 1 year, to explore a shorter prison stay than base-case.
2. 10 years, to extend the prison stay.
3. 17 years, to represent the mean length of life sentence.(29)

In the base-case analysis health utilities were taken from the literature, this scenario explores sing health utilities reported specifically by PiC in the TIPs PiC questionnaire using the EQ-5D-3L measure.

1. Analysis was undertaken to extract utilities for smoking status and pre- or post-policy implementation; these utilities may reflect the effects of SHS exposure on never-smokers. Only PiC utilities were applied, as the assumption was made that staff may not be exposed to SHS outside work. Utilities from Phase 1 were applied for the pre-policy implementation models, and from Phase 3 for the post-policy implementation model.

In the base-case analysis mortality for PiC was estimated using the Scottish SMR reported in Graham et al.(16), in this scenario analysis we apply and alternate SMR.

1. The alternative SMR were lower than the base-case ratios and taken from research in Georgia, US.(17)
2. There is a possibility that canteen data are underestimating spend on tobacco and NVP as PiC identified as smokers may have only been occasional smokers or making purchases to use as currency. This scenario analysis used spend reported in the TIPs PiC questionnaire for ‘in prison’ time period. Phase 1 responses were used for tobacco spend pre-policy implementation. Respondents were asked to report ‘How much did you spend on cigarettes or tobacco from the canteen list in the past week?’ This weekly amount was converted to annual spend by multiplying by 52. Post-policy implementation NVP spend was derived from the Phase 3 question ’How much did you spend on e-cigs/vapes from the canteen list in the past week?’, again multiplied by 52 to convert it to an annual cost.
3. PiC tobacco spend in the ‘post-prison’ was replaced by ‘in prison’ canteen data spends on tobacco.
4. Best practice when evaluating interventions with long-term health benefits or public health interventions is to conduct a sensitivity analysis using 1.5% discount rate.(35)

*Table 3: Scenario analyses parameters*

|  |  |  |
| --- | --- | --- |
| **Scenario analysis** | **Parameter (mean)** | **Source** |
| 1. **PiC smoking resumption on release: TIPS questionnaire**
 | 75% | TIPs PiC questionnaire |
| 1. **PiC smoking resumption on release: Ashley table**
 | 90% | Realistic estimate between TIPs PIC questionnaire and 100% assumption  |
| 1. **PiC time in prison: 1 year**
 | 1 |  |
| 1. **PiC time in prison: 10 years**
 | 10 |  |
| 1. **PiC time in prison: 17 years**
 | 17 |  |
| 1. **Utilities TIPS PiC questionnaire**
 |  | TIPS PiC questionnaire |
| Phase 1: Former smoker | 0.778 (SD 0.21) |
| Phase 1: Current smoker | 0.722 (SD 0.256) |
| Phase 1: SHS exposed non-tobacco smoker | 0.777 (SD 0.225) |
| Phase 3: Non-tobacco smoker | 0.779 (SD 0.235) |  |
| 1. **PiC mortality: Spaulding et al**
 |  | Spaulding et al(17) |
| In prison male | SMR 0.85 (95% CI 0.77 to 0.94) |
| In prison female | SMR 1.03 (95% CI 0.47 to 1.95) |
| Out prison male | SMR 1.51 (95% CI 1.45 to 1.58) |
| Out prison female | SMR 2.56 (95% CI 2.13 to 3.06) |
| 1. **‘In prison’ tobacco and NVP spend: TIPS PiC questionnaire**
 |  | TIPS PiC questionnaire |
| * Tobacco
 | £693 (SD 51.48) |
| * NVP
 | £544 (SD 46.66) |
| 1. **‘Post-prison’ tobacco spend: canteen ‘in prison’ data**
 | £412 | TIPS canteen data  |
| 1. **1.5% discount rate**
 | 1.5% | NICE(36) |

## Health economic evaluation – within study sensitivity analyses results tables

This section contains within study sensitivity analyses results.

Table : Cost-consequence analysis regression framework sensitivity analyses (SA2) results (costs and outcomes)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  **(Phase 1)** |  **(Phase 2)** |  **(Phase 3)** | **Change Phase 1 v Phase 2**  | **Change Phase 2 v Phase 3**  |
| **Observed monthly mean** **(standard deviation)** **N** | **Co-efficient (95% CI)** | **p-value** | **Co-efficient (95% CI)** | **p-value** |
| **People in custody** |
| **Costs** |
| GP/nurse visits | £3.62 (10.8) n=2368 | £4.24 (23.2) n=1842 | £4.72 (26.4) n=1362 | 0.619 (-0.438 to 1.68) | 0.25 | 0.481 (-1.24 to 2.20) | 0.59 |
| Tobacco | £24.67 | £24.67 | N/A | N/A | N/A |
| **Outcomes** |
| Utilities Mean (SD) | 0.736 (0.248) n=2284 | 0.729 (0.246) n=1787 | 0.685 (0.269) n=1321 | -0.007 (-0.022 to 0.008) | 0.38 | -0.044 (-0.063 to -0.026) | 0.00 |

CI - confidence interval; Phase 1 - Pre-announcement Phase; Phase 2 - Preparatory Phase; Phase 3 - Post-implementation Phase

Table : Cost-consequence analysis interrupted time series sensitivity analysis results (costs and outcomes)

|  |  |  |  |
| --- | --- | --- | --- |
| **Cost**  | **Predicted means** | **Change Phase 1 v Phase 2** | **Change Phase 2 v Phase 3** |
| **Phase 1****£** | **Phase 2****£** | **Phase 3****£** | **Step change** | **Slope change** | **Step change** | **Slope change** |
| **Co-efficient (95% CI)** | **p-value** | **Co-efficient (95% CI)** | **p-value** | **Co-efficient (95% CI)** | **p-value** | **Co-efficient (95% CI)** | **p-value** |

|  |
| --- |
| **Costs** |
| **Sensitivity analysis 1 - all medication** |
| **Medication (all)** | 91.7 | 117 | 141 | 14.4 (-7.83 to 36.7) | 0.20 | -1.13 (-3.57 to 1.32) | 0.36 | 3.31 (-19.4 to 26.0) | 0.77 | -0.008 (-3.56 to 3.54) | 0.996 |
| **Sensitivity analysis 2- including open prison** |
| **Ambulance** | 0.791 | 1.16 | 1.34 | 0.269 (-0.177 to 0.716) | 0.23 | -0.059 (-0.111 to -0.007) | 0.03 | 0.325 (-0.071 to 0.720) | 0.10 | 0.020 (-0.046 to 0.085) | 0.54 |
| **Medication (nicotine dependence)** | 1.89 | 2.42 | 2.79 | -0.224 (-0.679 to 0.232) | 0.33 | 0.039 (-0.030 to 0.108) | 0.26 | -0.474 (-1.66 to 0.715) | 0.42 | -0.039 (-0.216 to 0.139) | 0.66 |
| **Medication (smoking related illness)** | 2.17 | 0.814 | 0.683 | -3.02 (-9.69 to 3.66) | 0.37 | -0.314 (-0.963 to 0.335) | 0.33 | -0.269 (-0.772 to 0.235) | 0.29 | -0.001 (-0.049 to 0.046) | 0.97 |
| **Medication (all)** | 91.1 | 115 | 138 | 13.1 (-7.81 to 34.1) | 0.21 | -1.38 (-3.76 to 0.994) | 0.25 | 1.98 (-18.2 to 22.1) | 0.84 | -0.219 (-3.52 to 3.08) | 0.89 |
| **E-cigarettes** | N/A | 1.77 | 18.0 | N/A | N/A | 11.1 (9.18 to 13.0) | 0.00 | -0.772 (-1.32 to -0.224) | 0.01 |
| **Outcomes** |
| **Sensitivity analysis 2 – including open prison** |
| **Prisoner on staff assaults** | N/A | 0.004 | 0.004 | N/A | N/A | -0.001 (-0.003 to 0.001) | 0.34 | -0.0001 (-0.0004 to 0.0002) | 0.40 |
| **Prisoner on prisoner assaults** | N/A | 0.028 | 0.039 | N/A | N/A | 0.004 (-0.001 to 0.009) | 0.14 | -0.0008 (-0.002 to 0.00005) | 0.06 |
| **Fires** | 0.0009 | 0.0016 | 0.0007 | 0.0005 (0.00004 to 0.001) | 0.04 | 0.00003(-0.00004 to 0.0001) | 0.34 | -0.009 (-0.002 to -0.000008) | 0.048 | -0.00004 (-0.0001 to 0.00007) | 0.48 |
| **MoRS** | 0.012 | 0.036 | 0.046 | 0.009 (0.0008 to 0.016) | 0.03 | 0.0002 (-0.0006 to 0.001) | 0.65 | 0.002 (-0.008 to 0.013) | 0.63 | -0.0001 (-0.001 to 0.001) | 0.92 |

CI - confidence interval; Phase 1 - Pre-announcement Phase; Phase 2 - Preparatory Phase; Phase 3 - Post-implementation Phase

Table : Cost-effectiveness analysis costs broken down into components (sensitivity analyses)

|  |  |  |
| --- | --- | --- |
| **Resource** | **Pre-announcement £** | **Post-implementation £** |
|
| ***People in custody***  |
| **Sensitivity analysis 1 – all medication** |
| ***Health services resources***   |
| GP/nurse visits  | 44 | 57 |
| Inpatient | 122 | 92 |
| Outpatient | 45 | 30 |
| Mental health stays | 2,548 | 2,599 |
| A&E visits | 18 | 18 |
| Ambulance | 8 | 16 |
| Medication – all  | 1,108 | 1,689 |
| ***Personal***   |
| Tobacco |  302  |  -  |
| E-cigarettes |  -  |  219  |
| **Total**  | **4,195** | **4,720** |
| **Sensitivity analysis 2 – including open prison** |
| ***Health services resources***   |
| GP/nurse visits  |  43  |  57  |
| Inpatient |  122  |  92 |
| Outpatient |  45  |  30  |
| Mental health stays |  2,548  |  2,599  |
| A&E visits |  18  |  18  |
| Ambulance |  9  |  16  |
| Medication – smoking related illness |  29  |  8  |
| Medication – nicotine dependence |  22  |  33  |
| ***Personal***   |
| Tobacco |  299  |  -  |
| E-cigarettes |  -  |  216  |
| **Total**  | **3,134** | **3,069** |

Table : Cost-effectiveness results (sensitivity analyses)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Pre-announcement** | **Post-implementation** | **Difference** | **ICER** |
| **Person in custody** |
| **Sensitivity analysis 1 - all medication** |
| Mean cost | £4,195 | £4,720 | £525 |  |
| Mean PM2.5 (10µg/m3)  | 3.84 | 0.31 | 3.53 |
| Cost per additional 10µg/m3 reduction in PM2.5 |  | £149 |
| **Sensitivity analysis 2 - including open prison** |
| Mean cost | £3,134 | £3,069 | -£65 |  |
| Mean PM2.5 (10µg/m3)  | 3.84 | 0.31 | 3.53 |  |
| Cost per additional 10µg/m3 reduction in PM2.5 |  | -£18 (Post dominates Pre) |

ICER – incremental cost-effectiveness ratio

Table : Cost-utility analysis (sensitivity analsyis)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Pre-announcement** | **Post-implementation** | **Difference** | **ICER** |
| **Person in custody** |
| **Sensitivity analysis 1 - all medication** |
| Mean cost | £4,195 | £4,720 | £525 |  |
| Mean quality adjusted life-year  | 0.736 | 0.682 | -0.054 |
| Cost per quality adjusted life-year  |  | -£9,723 (Post is dominated by Pre) |
| **Sensitivity analysis 2 - including open prison** |
| Mean cost | £3,134 | £3,069 | -£65 |  |
| Mean quality adjusted life-year  | 0.736 | 0.685 | -0.051 |  |
| Cost per quality adjusted life-year  |  | £1,272 |

ICER – incremental cost-effectiveness ratio

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