Introduction

This Annex to the Airwave Data Dictionary[1] provides background material on the clinic and laboratory assays datasets. For variable-level documentation, please consult the metadata files that accompany the dataset[2].

Most analysts will find this document provides sufficient detail on data collection methods. However, detailed SOPs are available to approved researchers who want to know more. Feel free to contact the Study team if so.

More information on the Study is available at https://police-health.org.uk/.

Configuration

Title	Data Dictionary, Annex A
Subject	Background material on the clinic and laboratory assays datasets
Version	4
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Changes at Version 4

Versions 1 – 3 of this Annex were created to support extracts available locally at Imperial and at the DPUK tenancy at Swansea University. This is Version 4 and is created to support datasets at UK LLC. Over time, it will become the standard at all TREs supporting Airwave.

General Topics

The following sections discuss general subjects of interest.

Exclusions from TREs

Datasets are formatted identically whether they are created for Imperial's local TRE ("CSRE") or external TREs. However, Study participants are permitted to exclude their data from use on external TREs whilst remaining in use on CSRE. As of September 2025, 299 / 68687 records (0.4%) are excluded from external TREs for this reason.

Value Rounding

Numeric values have been rounded to the number of decimal places consistent with the measurement method. For example, pulse rates are measured to integer beats per minute, and the mean over three measurements is reported to one decimal place.

Identifiers

Two identifiers are used within this dataset:

- study_id identifies a member of the cohort (a unique person). Using study_id, analysts can link successive visits over time, as well as link across and between Airwave datasets.
- visit_id identifies the screening appointment(s) made by that person. All data collected during one visit is identified using the same visit_id.

Previous users of our data will be familiar with part_id, which fulfilled the same role as study_id and is now being progressively retired. Label visit_id is synonymous with its old name, barcode.

Sentinel Values

Airwave datasets have always used sentinel values. In earlier versions of this dataset, numeric variables whose valid range is >= 0 used negative numbers to document why a value was missing. The problem was that not all researchers fully read the documentation, resulting in errors when statistics were computed that interpreted the sentinels as genuine values.

In this version, we are changing the sentinels (Table 1), using literal text that is at least partially self-documenting. They are however not present in the values metadata file because it's not clear that numeric variables are meant to be documented this way. Most packages have standard methods of skipping sentinels when all you are interested in are the numbers.

Table 1: Sentinel Values

Sentinel	Meaning
c_ex_protocol	Measurement was outside the protocol when this screen was conducted.
c_not_applicable	For example, we did not ask males if they were pregnant
c_value_conflict	Two or more plausible but conflicting values were obtained and the usual rules for choosing between them failed
c_unusable	A value was recorded, but we have reason to believe it is wrong / unreliable / physically impossible. You may decide to reject other outliers, as we have redacted only the most egregious
c_not_found	The default when none of the above apply.

Data Collection Phases

Recruitment of the Airwave cohort began in July 2004 and finished in March 2015. Not every police force in Great Britain had been recruited into the Study by 2015, and we could have continued for further years had we been funded to do so.

Baseline

The baseline phase includes the whole of the recruitment period. It can be subdivided into pilot and main rollout phases. The pilot operated from July 2004 until approximately August 2006. Switch-over occurred on a clinic-by-clinic basis, so for a short while, both pilot and main study SOPs were in use simultaneously.

Follow Up Phase

A programme of follow-up began in November 2015. To qualify, a participant had to have a previous clinic visit at least 5-years prior, although exceptions do exist. Although the design of follow-up started with the premise of repeating measurements taken years before, we also added tests to the protocol and removed some. We changed laboratory more than once.

The main phase of follow-up began in November 2015 and was suspended in March 2020. Airwave was active in June and July of 2020, contributing to COVID research as part of REACT2 Substudy 4. A further pandemic-era protocol was rolled out in January and February of 2021, supported by Siemens Healthineers. Although focussed on COVID research, these visits contributed to Airwave's follow-up campaign.

The pandemic also gave us the opportunity to add participants who had no baseline clinic visit but who had joined the cohort by completing a questionnaire. Hence, some first clinic-visits do take place after baseline completion date.

The final phase (so far) of clinic-based follow-up took place between March and August 2023.

Evolution of the Protocol

The protocol evolved over time, and you will notice this in the preponderance of c_ex_protocol in, for example, variables reporting blood sodium and potassium levels. In some cases, variables not collected by the nurse (lifestyle questions, for example) were relocated to the clinic-survey. This was a self-administered, tablet-based questionnaire completed in-clinic before or after the nurse-based phase. You can apply for access to this dataset separately.

The main changes in protocol occurred at the end of the pilot and the main rollout phases. Protocols during the COVID-19 pandemic were also significantly curtailed.

Repeat Visits

Some participants had a second visit several months after their first one. This was done to evaluate the consistency of measurements spanning brief time periods. Offered randomly to every twentieth participant, in practice somewhat fewer attended. A small quantity of people not chosen managed to arrange their own repeat screen - for whatever reason.

Clinic Topics

This section addresses some topics specific to the clinic-based phase of the visit. This was a one-on-one activity supervised by a nurse or other healthcare professional and typically took 30 – 45 minutes. Note that certain specialise data were collected in clinic, the results of which are available in other datasets: for example, the ECG (electrocardiogram) results.

Blood Pressure

Participants generally have at least three blood pressure readings, taken consecutively whilst sitting. Each records pulse rate, systolic and diastolic blood pressures. Participants self-reporting as diabetic may have an additional set of readings, taken whilst standing.

Anthropomorphic Measurements

Most participants have two measurements of height, weight, waist-girth, hip-girth and sitting-height (height measured whilst sitting on a stool). Sitting-height measurements are reported with the height of the stool already subtracted. Our earlier documentation reported the stool height to be 60.7 cm. Later measurements showed 60.4 cm to be more accurate.

Body Composition Analysis

These measurements were made using a Tanita analyser. Fat percentage and total body water were derived from impedances using the Tanita's inscrutable black-box program. Despite repeated requests, we were unable to persuade the supplier to provide us with the algorithms, or references to any independent evaluations of their methods.

We understand (but without verifying) that the Tanita differentiates between "athletic" and "standard" body-types, which is one of the variables entered into the machine. To determine this, two questions were asked: one to the participant, asking whether they take "ten or more hours of intense exercise per week"; and the second was the nurse's subjective assessment of body-type.

There are three main contraindications: pregnancy (because of extra water in the body); the presence of metal objects (affects impedance), and the presence of a pacemaker (safety).

Grip Strength

For a small number of the most recent visits, we measured grip-strength using the Jamar device. Results are based on two measures of each hand.

Split Samples

We operated a split-sample protocol to verify the accuracy of sample handling from collection to final storage of surplus material in the biorepository. This was considered particularly relevant when sample handling was performed manually.

The essence of the process was that on random occasions, an extra set of bloods were taken from a willing participant and submitted for assay using a different visit_id. The laboratory was blind to the sample being a "split" and processed them normally. Split sample results were compared to those of the original and any differences exceeding natural experimental error investigated. We performed 1,254 split samples and concluded that the accuracy of sample handling was excellent.

Split samples were stored in the biorepository along with the main sample for the donor. The results are excluded from these datasets but anyone wishing to conduct research using them can request access.

There is a fuller description of quality assurance techniques used in the main Data Dictionary in section *Validation of Collected Data*.

Laboratory Results

At each visit we attempted and mostly succeeded in collecting a blood and urine sample. Samples were stored in a fridge during the working day and transported overnight in a thermoporter to a laboratory. We placed a TempTale® monitoring device in the thermoporter during some overnight passages of the pilot phase to verify that temperatures were maintained at 2°C to 4°C.

At the laboratory, haematology and chemistry assays were generally conducted on the day of arrival (the day following collection). The coagulations and Elisa plate reader tests were done later. Variables record the interval between blood collection and assay.

Participants Failing Venepuncture

Participants who were unable to provide a blood sample at the first time of asking were given the opportunity to return to the clinic on a later date where a second attempt was made. In these cases, assays may be dated days or weeks later than the original clinic visit.

The SOP required nurses to submit a form for each re-bleed; however, we know that this was not always adhered to. When we are confident in the resubmission dates, the assay-interval fields (elisa_assay_interval, clinchem_assay_interval, haematology_assay_interval and coagulation_assay_interval) have been computed based on the re-bleed date.

Laboratories and Analysers

We used a variety of laboratories and analysers during the project. Most baseline results were assayed at Northwick Park Institute of Medical Research (NPIMR). During the Pilot, we used its existing elderly equipment: a COBAS Mira for clinical chemistry, an H1E for haematology and an ACL-300 for coagulation. For the main baseline, we upgraded to an Ilab 350 (chemistry); Advia 2120 (haematology); ACL-8000 (coagulation), and an Elisa Plate Reader for C-peptide.

Charing Cross Hospital conducted the assays from November 2015 until 2021. A variety of NHS and third-party commercial laboratories were used for the final phase of follow-up.

Glycosylated Haemoglobin

Glycosylated haemoglobin (HbA1c) is reported using two different sets of variables. The Diabetes Control and Complications Trial (DCCT) method was used until May 2014, at which point it was superseded by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) method. The change was imposed upon us by the suppliers. We understand the change resulted from the National Glycohaemoglobin Standardisation Program, and was driven by a recognition that the DCCT assay reported too many false positives for diabetes.

The two methods both measure the proportion of HbA1c relative to total haemoglobin. However, DCCT is reported in units of g/dl whereas IFCC uses mmol/mol. The range of reported values for each method are different, apparently to avoid errors of misinterpretation during the changeover.

Because of the differences, the two series are not directly comparable. However, conversion formulae and reference ranges are published and, according to advice from NPIMR (May 2014), the "normal" ranges for the IFCC method are:

- 20-42 mmol/mol (4-6% in DCCT units) in non-diabetics
- 42-64 mmol/mol (6-8% in DCCT units) in controlled diabetics
- 64-up to 195 mmol/mol (8-20% in DCCT units) in uncontrolled diabetics.

The conversion formulae below were attributed to the IFCC organisation, though an article on Wikipedia uses slightly different coefficients. These are, we note, also different from the first time we reviewed them (11th January 2017).

A comparison between the methods using a test sample resulted in IFCC values a little lower than the translated DCCT value, although no test of statistical significance was made.

Population Distribution for IFCC Assay Methods

IFCC assays were performed using one of two different methods: a turbidimetric method was used at NPIMR; and an ion-exchange / HPLC method at Charing Cross. A complication is that the distribution of values for these do not coincide. Although we did not conduct a method comparison study when moving laboratories, a brief analysis in 2018 showed that the population mean using the ion-exchange method is roughly one standard-deviation greater than the mean found using the turbidimetric method. Here is some advice gleaned from a consultant in Metabolic Medicine who was also an Honorary Research Fellow at Imperial College, "[it]…*will not be possible to derive a population mean/SD as these will always be dependent on the method used… Although the methods correlate there will be absolute differences due to the methods used."*[3]

Differential White Cell Counts

This is an analysis of the types of white cell. The value reported by the assay is the percentage of each cell-type as a percentage of total white cells. In aggregate, therefore, the sum should equal 100%. In practice, values sometimes sum to more or less than unity, which we consider to be an artefact of the method.

The clinically significant result, however, is not the proportion but the absolute number (count) of cells. Here we report the computed counts, defined as the product of cell-percentage and total

white cells. Where the haematology machine reported a count, we report it; if not, we report a locally computed value.

Assay Intervals

We provide the time interval between venepuncture and assay for each of four assays: clinical chemistry, haematology, Coagulation analysis, and Elisa plate-reader.

Assay time is derived from the analyser's electronic record and the most recent blood collection date. The result is an average weighted by the quantity of assays.

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[1] Find the main Data Dictionary and other annexes, including this one, at our website: https://police-health.org.uk/researchers

[2] FORMAT OF DATA FILES: GUIDANCE FOR LPS DATA MANAGERS; Version 2.5, 4th April 2025.

[3] Email: Busbridge – Heard, 11th February 2019