

## Summary

**Objective:** Certification by treating physicians of fitness to drive in people with epilepsy creates a conflict of interest that may result in unsafe decisions, damage the doctor-patient relationship, expose the physician to legal liability and prevent optimal treatment. Ideally, the treating physician should provide objective clinical information to the driver licensing authority (DLA), which then determines fitness or otherwise. However, DLAs in Australia do not employ medical staff and the national standards are complex. Fitness is determined by the treating physician, according to published national standards. The purpose of this study was to determine the feasibility of using a decision tree to determine fitness, according to the Australian standards.

**Methods:** A decision tree was constructed to use clinical data to determine whether a patient met the national standard to drive a private motor car, failed to meet it or required further assessment. A form was designed to collect the necessary clinical data from the treating physician. A computerised version of the decision tree was then used in a pilot in two Australian states in parallel with the existing certification system. Four hundred and thirty-nine drivers with declared epilepsy and their treating physicians were invited to participate when their annual driver licence review was due.

**Results:** Two hundred fifty-three (58%) forms were returned. All patients were considered fit to drive by their physician. Seventy-six per cent had not had a seizure for over two years. In 88.1%, there was agreement between the decision tree and treating physician, with 3.6% identified by the decision tree as requiring review. Although considered fit by their physician, 6.3% did not meet the national standard to drive.

**Significance:** The decision tree model is a practical alternative to fitness certification by treating physicians. ~~The model could be used with any set of driving standards that~~ **This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as [doi: 10.1111/EPL.16020](https://doi.org/10.1111/EPL.16020)**

~~rely on objective data rather than opinion.~~ This Australian pilot can serve as a model for applying objective standards to driving assessments in other jurisdictions, using local driving standards. It has the potential to improve road safety by avoiding the negative effects of certification by treating physicians and can cope with complex standards. It is now in use in two states of Australia.

*Key Words:*

Seizures; driving; epilepsy regulation; public health

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PROF. ERNEST R SOMERVILLE (Orcid ID : 0000-0001-8789-1122)

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Title

A decision tree to determine fitness to drive in epilepsy: Results of a pilot in two Australian states.

Author:

Ernest R Somerville<sup>1,2</sup> on behalf of the Driving Committee of the Epilepsy Society of Australia

<sup>1</sup>Prince of Wales Hospital, Sydney, Australia

<sup>2</sup>University of New South Wales, Sydney, Australia

Contact:

Prof Ernest Somerville

Comprehensive Epilepsy Service

Prince of Wales Hospital

Barker Street

Randwick NSW 2031

Australia

Tel: +61 2 9382 3805

Fax: +61 2 9382 3899

Email: [e.somerville@unsw.edu.au](mailto:e.somerville@unsw.edu.au)

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## **Introduction**

Disqualification from driving is one of the greatest concerns of people with epilepsy.<sup>1</sup> Half of respondents to a survey of patients attending an Australian epilepsy clinic nominated driving restrictions as their greatest concern in relation to epilepsy – greater than work restrictions, lifestyle restrictions, stigma, medication side-effects and the risk of seizures.<sup>2</sup> The decision as to whether a person with seizures should be licensed to drive is legally the responsibility of the driver licensing authority (DLA). However, in practice, many DLAs pass this task to the treating physician.<sup>3; 4</sup> This may create a conflict of interest: on the one hand, the physician is acting as the advocate of the patient, but at the same time, is performing the task of an agent of the DLA. This may occur at a time when the physician is attempting to build a collaborative relationship with the patient and gain their trust. Patients may blame the physician for depriving them of what may be perceived as a fundamental right or of their livelihood. The physician may feel pressured by the patient to make a “favourable” decision in order to preserve their relationship with the patient or may feel sympathy.<sup>5</sup> An objective assessment by the treating physician is impossible in this situation and the result may be an unsafe decision or damage to the therapeutic relationship.<sup>3; 6</sup> The physician may also be held legally liable, should a crash occur as the result of a seizure.<sup>7; 8</sup>

The Australian standards of driving fitness of people with seizures<sup>9</sup> are complex and therefore sometimes misapplied. A questionnaire completed by Australian neurologists found that only 55.5% of respondents knew the standard that applied to drivers after their first seizure. Furthermore, there was a low rate of agreement as to fitness between neurologists and non-neurologists.<sup>10</sup>

In Australia, drivers who have experienced one or more seizures are legally obliged to notify their state or territory DLA. The DLA then asks the driver to have their physician sign a form that certifies them fit or unfit to drive, according to published

national standards.<sup>9</sup> Those certified fit to drive are reviewed annually in the same manner. The required period of seizure freedom before driving varies with the circumstances. The result is a complex set of standards, with required seizure freedom of 0, 1, 3, 6, and 12 months applying to 10 clinical situations.

In 2002, a man with a history of epilepsy had a seizure while driving a bus on a rural road in Australia, colliding with a tree. He and three of his passengers died. The coroner recommended the driver's neurologist, who had certified him fit to drive, face criminal charges.<sup>7</sup> The Australian and New Zealand Association of Neurologists (ANZAN) and the Epilepsy Society of Australia (ESA) then advised the DLAs throughout Australia that driving fitness decisions should be made by the DLA, based on objective information (rather than opinion) provided by the treating physician(s).<sup>11</sup> In order to assist the DLAs, a computerised decision tree was constructed to determine whether, on the basis of objective data, the patient meets the national standards to drive a private motor car. A pilot was conducted in collaboration with the DLAs in two Australian states.

The aim of the pilot was to evaluate the feasibility of using a decision tree model to apply a set of driving standards and not to examine the merits of those standards.

### **Methods.**

The Australian national standards of fitness to drive in those with seizures require varying periods of seizure freedom, depending on a number of patient-specific variables, such as whether treatment has only recently started and whether the patient has had a crash due to a seizure (Table 1).<sup>12</sup> These patient specific variables were transformed to a series of Yes/No questions.

These questions were then placed on a form (Supporting Information). Additional fields on the form were: date of the last seizure, date the form was signed and whether the doctor wished to provide any relevant additional information or comment. The sequence of questions was designed to allow shortcuts that minimised the amount of data required and time necessary to complete the form. For example, if a driver had been free of seizures for more than two years, the only other question to be answered was whether medication would be withdrawn.

A decision tree was constructed to calculate the recommended period of seizure freedom required for individual patients, depending on the answers to the patient-specific questions (Figure 1 and Table 1). This period was added to the date of the last seizure and displayed as the earliest date before reassessment. If this date was earlier than the date the form was signed, the patient was considered fit. The decision tree was then computerized, using Visual Basic (see Supporting Information for screenshot video examples) and provided to the DLAs in New South Wales and Victoria. The questions were processed in a sequence that produced a default output of unfit until the standard maximum seizure-free period was attained, unless there were characteristics that allowed a shorter period. The sequence was designed to apply the greater period of licence suspension in cases where the patient has more than one characteristic, each with differing seizure freedom requirements. A number of safety checks were added, including: asking for the date of the last seizure but also asking if this was more or less than two years ago. If the date and the answer to the two-year question disagreed, an error message was generated. The maximum required seizure-free period was the default, with shorter periods allowed if the applicant's situation met the appropriate standard. If the day of the month or the month was blank or unknown, the last day of the month or the last month of the year were entered respectively, in order to avoid overestimation of the duration of seizure freedom. If any relevant questions were left unanswered, an error message was generated. Error messages were also generated if inconsistent answers were provided, such as seizures occurring only during sleep for at least the last 12 months but a seizure having caused a crash within the last 12 months.

The output of the decision tree was 1. "Fit" if the driver met the standard or 2. "Unfit until [the earliest date that the driver could meet the relevant standard] and requires reassessment at that time" or 3. "Requires review". Reviews were triggered if the physician provided any comment, if medication was to be withdrawn within two years of the last seizure or if medication was to be withdrawn from a driver with seizures only during sleep or with seizures that did not impair consciousness and driving ability. In order to reduce the number of reviews, the decision tree was later modified, so that comments from the physician in support of a driver's fitness triggered a review only if the decision tree would otherwise determine them to be unfit. Detailed results

included here refer to the final version of the decision tree. Forms containing incomplete or inconsistent data were not evaluated by the decision tree, but their data were included in the remainder of the analysis.

The pilot was administered by the DLAs of two Australian states – in New South Wales by the Roads and Traffic Authority and in Victoria by VicRoads, on behalf of the Austroads Licensing and Registration Task Force, representing all DLAs in Australia. It was carried out in parallel with the usual annual medical review. A few days after mailing of the annual medical report form to drivers with declared epilepsy, the pilot form was sent, accompanied by a letter inviting the driver to participate in the pilot and a similar letter for the driver to take to their physician. Participation was voluntary and drivers and physicians were told that information provided on the pilot form would not influence the licensing decision. The opinion of physicians was also sought on the ease of use of the form and the time taken to complete it. 265 forms were sent in New South Wales and 174 in Victoria.

Data from pilot forms were entered into the decision tree by nonmedical DLA staff and later checked by one of the authors (ERS) after removal of driver and physician identifying information from the forms.

The output of the decision tree was then compared with the fitness determination by the driver's physician. Data provided by neurologists were compared with that provided by non-neurologist physicians.

### **Results.**

Two hundred fifty-three (58%) of 439 forms were returned, of which 5(2%) were unusable. Seventy-two per cent were completed by non-neurologist physicians, mostly family practitioners. Average time to complete the form was 5.4 min. Characteristics of the applicants' epilepsy relevant to the standards in force at the time of the pilot are shown in Table 1.

All drivers were considered fit by their physician. Agreement between the first version of the decision tree and the physician was 58.1%, with 34.8% recommended for review and 5% unfit. After modification of the decision tree, agreement rose to

88.1% and reviews fell to 3.6%, with 6.3% of drivers unfit (Figure 2). Disagreements between the output of the final version of the decision tree and the physician's determination were due to a variety of reasons (Table 2). Most disagreements were due to the physician considering a patient fit who did not meet the national standards. Reviews were because of relevant comments by the treating physician, who considered the patient fit, although not satisfying the national standard.

Three-quarters of drivers had not had a seizure for at least 2 years and 86% had not had a seizure for 12 months or more. The median time since the last seizure was 59 months (range 0 days - 40.3 years) (Figure 3).

Comparison of responses from neurologists and non-neurologists revealed significant differences in the proportion of patients seizure-free >2 years (neurologists 49.3% (median time since last seizure 21.5 months), non-neurologists 86.3% (median time since last seizure 65.5 months),  $p < 0.001$ ;) and those taking no anti-epileptic therapy (neurologists 2.8%, non-neurologists 16.5%,  $p = 0.003$ ). Disagreements between the decision tree and the treating physician were more common when the forms were completed by neurologists (16.9% compared to 2.2% for non-neurologists,  $p < 0.001$ ).

## Discussion

The pilot demonstrated that the use of objective data regarding a driver's epilepsy provided by their treating physician can be used by non-medically trained DLA staff to determine whether most people with epilepsy are fit to drive, according to published national standards. The complexity of the standards did not prove to be an obstacle.

There was a high rate of agreement (88.1%) between the final version of the decision tree and treating physicians, so that only a small and manageable number of reviews (3.6%) were recommended by the decision tree. In the pilot, there were no cases in which the physician considered the driver unfit. However, to allow for the situation where the physician has concerns over the fitness of a driver who nevertheless meets the published standards, the data collection form should include a field for the physician to express those concerns, thus triggering a review.

The initial version of the decision tree referred for review all cases where the physician provided any additional comment. However, most of the comments were unhelpful (e.g. restating the time since the last seizure, commenting that the patient was compliant with therapy, was fit to drive or had seen a neurologist). The decision tree was therefore modified, so that additional comments by the physician resulted in a review only if the patient would otherwise be unfit. This reduced the number of cases requiring review by approximately 90% from 34.8% to 3.6%.

The great majority of NSW and Victorian licensed drivers with epilepsy are fit to drive, using the current requirement of 12 months of seizure freedom (86.2% of participants) or the two year requirement in force at the time of the pilot (75.9% of participants) (Figure 3).<sup>9,12</sup> The median time since the last seizure was almost 5 years (range 0 days - 40.3 years). However, 6.3% of drivers were considered fit by their physician, despite failing to meet the national standard. The reasons for disagreement between the decision tree and the treating physicians were of concern. Most resulted from physicians shortening or ignoring the required duration of seizure freedom. Five patients were considered by their physician fit to continue driving despite planned withdrawal of therapy and two were considered fit despite the physician considering that the factor provoking their last seizure was likely to recur. A further patient had seizures that the physician felt did not impair consciousness and therefore did not render the driver unfit but it had not been verified by witnesses or video-EEG monitoring, as required by the national standards. One driver had been involved in a crash due to a seizure within the last 12 months. None of these drivers met the published standards and their physicians did not offer any comment as to why they should be allowed to drive. It is unknown whether physicians certified these drivers as fit because they misunderstood the national standards, because they disagreed with the standards, because they were influenced by sympathy for or pressure from the patient or because they did not wish to damage their relationship with the patient. A recent review of the epilepsy licensing system in the US state of Maryland, found an even more “liberal” assessment of fitness, with treating physicians recommending driving for 84.4% of applicants rejected by the Medical Advisory Board.<sup>13</sup>

The smaller proportion of patients reported by neurologists to be seizure-free >2 years (49.3%; median time since last seizure 21.5 months) than of those reported by non-

neurologists (86.3%; median time since last seizure 65.5 months) and the greater proportion of patients reported by non-neurologists to be taking no anti-epileptic therapy (neurologists 2.8%, non-neurologists 16.5%) reflect the fact that better controlled patients are less likely to be under regular follow-up by a neurologist. The greater rate of disagreement between the decision tree and the treating physician when the forms were completed by neurologists (16.9% compared to 2.2% for non-neurologists), is probably also because non-neurologists dealt with better controlled, simpler cases.

This pilot demonstrates that a decision tree can be used to determine fitness to drive according to even a complex set of standards. Such a decision tree could be used by DLAs, physicians or even by patients to determine fitness. However, the advantage of limiting its availability to DLAs is to remove the treating physician as far as possible from the licensing decision, thereby avoiding potential damage to their relationship with the patient and allowing a more objective determination of fitness.

Simple rules are easier to interpret and enforce but do not allow for the great variability in risk that exists among people with seizures, depending on their situation. A set of standards that allows driving by the greatest proportion of people with seizures who are fit to drive requires complexity. A disadvantage of complex standards is that they are more likely to lead to errors in their application and may be impossible for users to remember, particularly if they are not regularly certifying fitness (72% of the pilot forms were completed by non-neurologists)<sup>10</sup>. This is obviated by limiting the treating physician's role to providing clinical information and not requiring them to make a determination of fitness.

Distancing the treating physician from the licensing decision and limiting their role to the provision of clinical information is consistent with the Consensus Statement of the American Academy of Neurology, American Epilepsy Society, and Epilepsy Foundation of America, which states that "The licensing decision should be made by the state Department of Motor Vehicles (DMV) rather than by the treating physician... The treating physician should be responsible for reporting the pertinent medical facts on forms provided by the DMV."<sup>14</sup> The Second European Working Group on Epilepsy and Driving similarly recommended that "the final assessment of

driving ability should be done by an independent doctor, not by any treating physician.”<sup>15</sup>

The rules regarding fitness apply at all times, not just at the time of annual recertification. The licensing implications of a recurrent seizure will depend on the situation but would also be suitable for assessment using the decision tree.

An essential component of the model is an independent review mechanism for cases where automatic application of standards might result in unfair or unsafe determinations and for cases where the decision tree recommends review. A variety of review models have been used but are beyond the scope of this report and reviews were not examined in this pilot.

Forty-two per cent of drivers and/or their physicians declined to participate in the pilot. This may reduce the generalizability of its findings to all drivers with epilepsy. It is possible that physicians who knowingly ignored the fitness standards were more likely to decline participation in the pilot. This would have increased the already alarmingly high rate of noncompliance with the standards. However, to reduce this possible disincentive to participate, reassurance was provided to drivers and physicians that their participation would not over-ride the usual fitness certification by the treating physician. It is also possible that, in contrast to participants, non-participating drivers included some considered by their physician to be unfit or who had complex mitigating factors. The large majority of participants had been seizure-free for at least two years, making disagreement between the decision tree and the treating physician unlikely. The performance of the decision tree when handling more complex cases was therefore tested in a only a relatively small number of cases. Errors in data entry by non-medically trained staff could result in inappropriate driver licensing. However, several safeguards were incorporated in the computerised version of the decision tree to reduce that possibility. For example, achievement of the default period of seizure freedom was effectively asked twice - once by asking whether the required period had been achieved (24 months at the time of the pilot) and again by asking the date of the last seizure. Reviews were triggered if medication was to be withdrawn within two years of the last seizure or if medication was to be withdrawn

from a driver with seizures only during sleep or with seizures that did not impair consciousness and driving ability.

The reliability of the decision tree depends on the reliability of the data provided by the applicant, which may not always be accurate, either because seizures are unrecognized by the patient<sup>16; 17</sup> or because information is withheld by the patient.<sup>18;</sup><sup>19</sup> However, removing the treating physician from the role of decision-maker may foster greater truthfulness by avoiding the negative impact that unfavourable fitness decisions may have on the doctor-patient relationship.<sup>6</sup>

The decision tree relies on binary (yes/no) data and would not therefore be suitable for licensing systems that rely primarily on individual risk assessment. However, it attempts to identify cases in which an individual assessment is required. The form also allows the treating physician to provide extra relevant information and/or to request a case review. Similar decision trees could be constructed to handle different fitness standards in other countries and jurisdictions, provided those standards were based primarily on binary data rather than expert opinion or assessment.

Since completion of this pilot, the decision tree has been updated to conform to the latest Australian fitness to drive standards<sup>9</sup> and is in use in two Australian states (New South Wales and South Australia).

### **Key points:**

- Certification of driving fitness in epilepsy by treating physicians may create a conflict of interest and result in unsafe decisions
- The role of the physician should be to provide clinical data rather than opinion to the driver licensing authority
- A decision tree allowing driver licensing authorities to apply driving standards using individual clinical data is practical
- Most drivers with epilepsy satisfy the widely accepted standards of seizure freedom for one year (86% of patients) or two years (75%)

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Ron Granot computerized the decision tree.

Staff of Roads and Traffic Authority of New South Wales, led by Irene Siu and of VicRoads, led by Tina Vasiliadis, administered the pilot.

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### **Disclosure of Conflicts of Interest:**

ERS has served as a paid consultant for the National Transport Commission of Australia and received travel support from VicRoads in connection with the pilot.

### **Ethical Publication Statement:**

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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**Supporting information**

1. Form used to collect individual applicant clinical data.
2. Video screenshot of computerized decision tree examples.

**Figure Legends**

Figure 1. Decision tree. Driving fitness recommendations are in yellow boxes, with the applicable non-driving period before reassessment (see Table 1). ⓘ con, additional information provided by treating physician indicating concern that driving may not be safe; ⓘ pro, additional information provided by treating physician indicating that driver may be fit despite not meeting national standard; y, years; m, months; AED w/d, antiepileptic drug withdrawal; Rx, treatment; “Safe” seizures, seizures that do not impair consciousness or driving ability; Verified, consciousness and responsiveness verified by reliable witness or video-EEG; Sz-crash, motor vehicle crash due to seizure; Taper + 3m, period of dosage reduction followed by 3 months.

Figure 2. Fitness determination by treating physician (upper half) and decision tree (lower half)

Figure 3. Time since last seizure.

Each horizontal bar represents one driver. Red vertical line divides drivers whose last seizure was less than 12 months ago (left of red line) from those whose last seizure was more than 12 months ago (right of red line). Green line separates drivers whose last seizure was more or less than 24 months ago.

Table 1

Situation	Requirement to meet standard <sup>12</sup>	Drivers to whom standard applied (%)
Chronic epilepsy, not otherwise specified	24 months SF	192 (75.9%).
First seizure	6 months SF	0
Planned medication withdrawal in driver meeting other standards	Duration of medication taper and 3 months after last dose	6 (2.4%) (32 drivers (12.6%) were not taking AED)
Newly diagnosed	6 months SF after start of treatment	6 (2.4%)
Well-controlled before last seizure	3 months SF	51 (20.2%)
Last seizure provoked	1 month SF if previously well-controlled and provocation unlikely to recur	32 (12.6%)
Sleep-only seizures	Only seizures during sleep for 12 months	17 (6.7%)
Seizures not impairing consciousness	No restriction if verified by witness or	22 (8.7%)

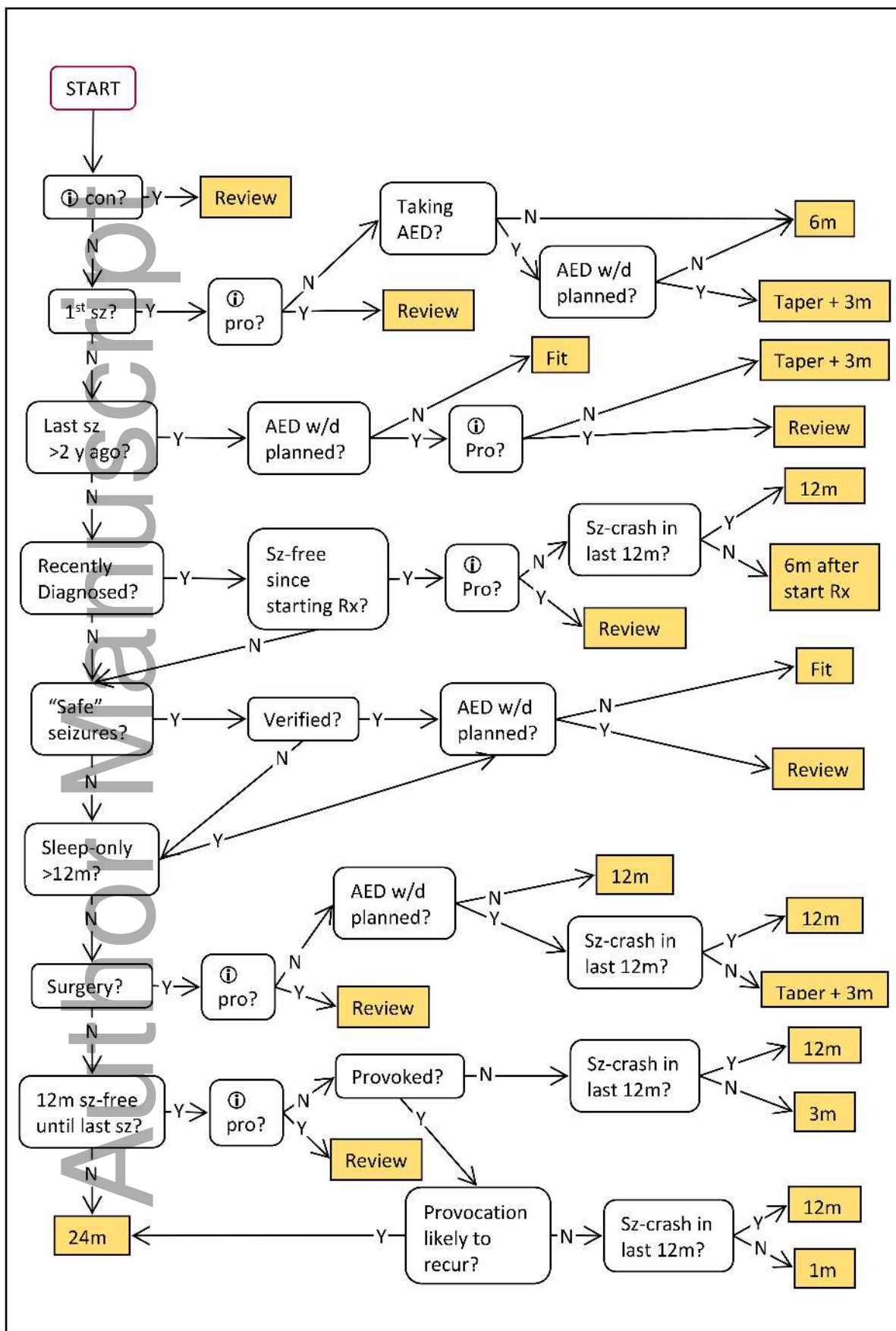
	video-EEG.	
Epilepsy surgery	12 months SF	4 (1.6%)
Crash caused by seizure	12 months SF	1 (0.4%)

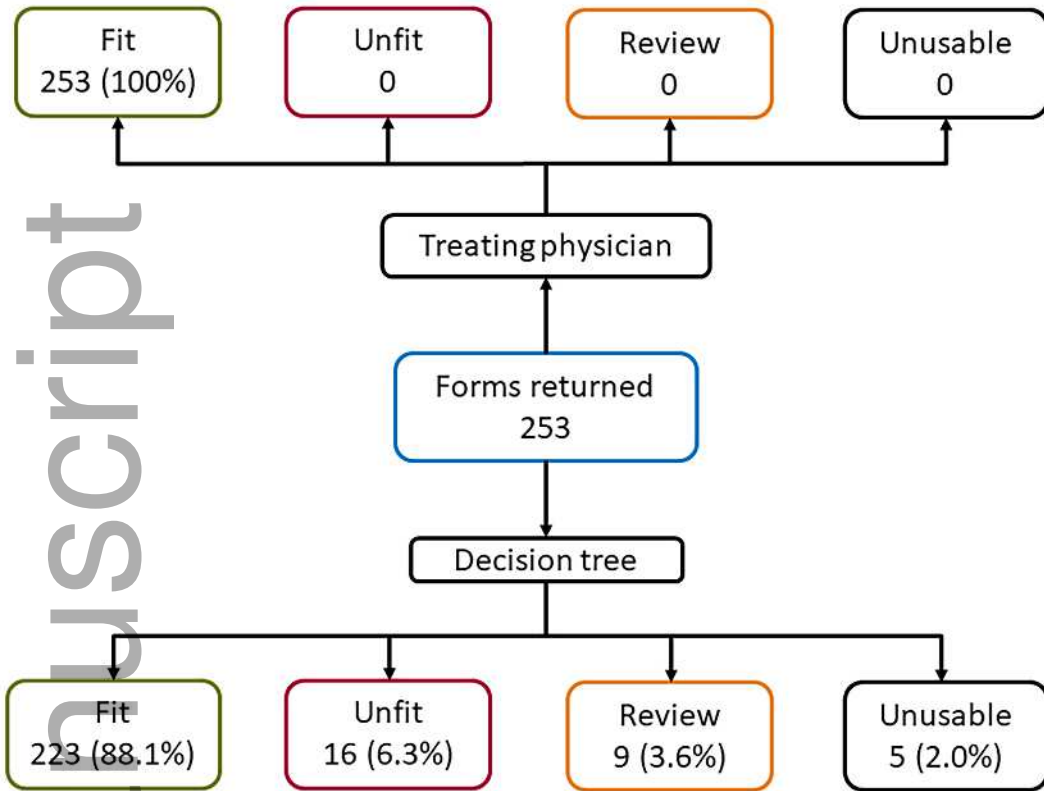
Table 1. Australian private driving standards<sup>12</sup> and number (%) of applicants to whom standard applied. No applicants with first seizures were included because forms were sent with annual medical review forms to drivers already possessing a conditional driving licence. “Well controlled” was not defined in the published standards but in the decision tree and in the current standards is defined as freedom from seizures in the 12 months before the last seizure. SF, seizure-freedom; AED, antiepileptic drug.

Table 2

<b>Reason for disagreement</b> <b>N = 16</b>	<b>Drivers (% of disagreements)</b>
Less than 2 years since last seizure without being eligible within a shorter period	8(50)
Planned medication withdrawal	5(31)
Not “well-controlled” before last seizure	2(13)
Last seizure provoked but provoking factor likely to recur	2(13)
Seizures not impairing consciousness but not verified by witness or video-EEG	1(6)

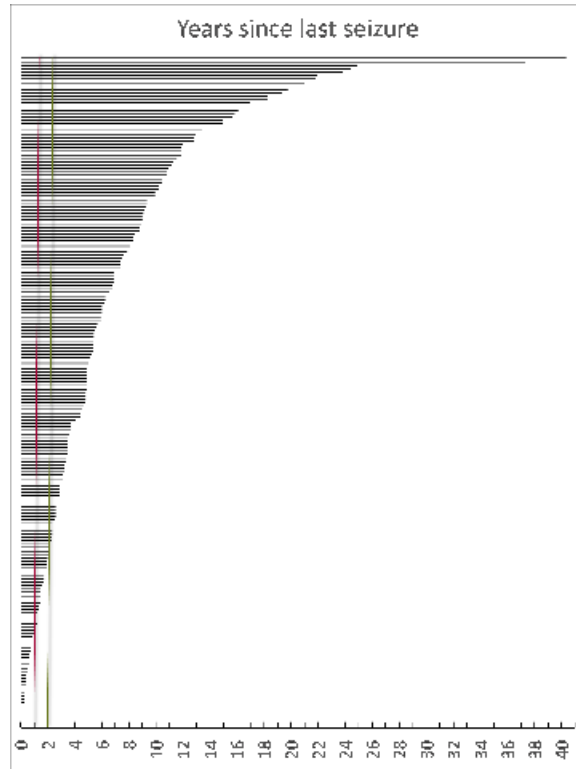
Table 2. Reasons for disagreement between treating physician and decision tree. “Well controlled” was not defined in the published standards<sup>12</sup> but in the decision tree and in the current Australian standards<sup>9</sup> is defined as freedom from seizures in the 12 months before the last seizure. In some drivers, there was more than one reason for disagreement.





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