Abstract

**Purposes:** Our study is interested in highlighting the nonagenarians’ clinical characteristics in the French Community of Belgium on the physical, nutritional, social and cognitive levels as well as on their medical treatment and medical history/comorbidities. By comparing them to a sample of octogenarians, we hope to identify significant differences in clinical characteristics, comorbidities, aggressiveness of the management and in mortality.

**Material and methods:** prospective observational multi-centric study. We included 52 nonagenarians and 43 octogenarians admitted in an acute geriatric Unit. Collection of social demographics data, number of medical exams in Emergency Unit, medical history, reasons for admission, survival at the discharge and at six months. Both groups have been compared using statistical methods.

**Results:** Nonagenarians were less dependent for IADL than eighty-year-old patients (p=0.027) whereas the ADL are similar in both groups; no significant difference concerning the risk of falling. On the social aspect, the nonagenarians tend to be widowers more often (p=0.08) without family. They seem to reside more in nursing homes before their stay in hospital (p=0.091). The number of medicines is similar in both groups, but people aged 90 take less depressants (p=0.029) and neuroleptics (p=0.039). Patients aged 80 have more diabetes Type 2 (p=0.028). The level of vitamin B12 is higher among the ninety-year-old (p=0.078) as well as the albumin ratio (p=0.064), whereas the weight tends to be lower (p=0.091). The mortality ratio during the hospitalization is similar (p=ns), but 6-month survival rates are lower for 90-year-old patients (p=0.009).

**Conclusions:** In the population studied, nonagenarians present some specific characteristics compared to octogenarians, such as a lower prevalence of diabetes and a better instrumental autonomy, while their living environment tends to be more institutional and their family is often not very present. To equal number of medicines, they consume less depressants and neuroleptics. Although their 6-month prognosis is logically worse that of the younger group, nonagenarians do not die more during hospitalization. Therefore, it is reasonable to adopt a medical approach aimed at not reducing the intensity of care too quickly, as long as the project has been discussed with the patient.
Added to these findings is the Baby Boom, an unexpected phenomenon. Located in the course of the 1940s until the end of the 1960s, it refers to the explosion of the birth rate which even doubled in a few years in some countries and is sometimes described as a “birth quake” with numerous aftershocks mainly in developed countries, especially those involved in World War II [5,6]. Although the baby-boomer population has already declined in 60 years, it plays and will continue to play an essential role in our society, for example, by modifying the age structure by 2030 when all members of this population will be 65 years old and over [6].

In 2002, Knickman JR and Snell EK were already interested in this population and proposed several measures to be implemented (adapted to the American health system) in order to anticipate the possible consequences of the crisis [7]. Born from 1946 to 1964 [8], these baby boomers will reach their nineties between 2036 and 2054, i.e. in a few decades.

In 2010, a group of Belgian general practitioners published the BELfrail study concerning 80 years and over (9). Starting from the postulate that the proportion of these patients living in Western countries would increase dramatically, they considered it necessary to study them in order to anticipate the related health care expenses and to ensure their sustainability.

Therefore, in view of the significant increase in nonagenarians in our geriatric wards, we looked at their characteristics in French-speaking Belgium. Are there significant differences with younger patients? Can we consider specific care? What about mortality and the resulting intensity of care? Note that in 2016, the Pew Research Center [8] reported that Generation Y or Millennials (people born from 1981 to 1996) had outnumbered the baby-boomer generation, suggesting the continuation of the trend described above.

**Review of literature**

By using the PubMed, Scopus or Google Scholar search engines with the terms “nonagenarians population study”, “nonagenarians characteristics”, “nonagenarians cohort study”, little information on the subject are available. In fact, most of the articles are limited to a particular theme (e.g., survival after total hip replacement or after myocardial infarction) except for a study by Petermans, et al. [10], demonstrating that nonagenarians have the same functional profile, but take fewer drugs, than octogenarians. In this study, the risk of functional and / or cognitive decline in nonagenarians was greater with a lower walking speed, but this did not seem to impact their evolution compared to octogenarians, even though they were more likely to live in a nursing home 6 months after discharge.

**Material and methods**

**Study design**

This was a multicenter prospective observational study conducted between October 2018 and December 2019 in the AGW of Jolimont Regional medical center and the Grand Hôpital de Charleroi (GHdC), Hainaut province, French-speaking Belgium. This study was approved by the ethics committee of the GHdC (B010201940891).

We recruited patients hospitalized in AGW, regardless of their reason for admission. The inclusion criteria were age (80 to 99) and service (AGW). There were no exclusion criteria other than refusal to participate in the study. For each patient, a consent form was distributed in duplicate (one for the patient, one for the investigators). If the patient was unable to make a decision (dementia, confusion, coma, etc.), a suitable document was given to the family and/or caregivers with a right of withdrawal in case of an next refusal when recovering the capacity to give consent.

**Data collection**

- **Sex**
- **Height**
- **Nutritional status**
  - Weight, height, BMI, MNA sf, albumin, pre-albumin, inflammatory syndrome, folates, vitamin B12
- **Functional status**
  - Tinetti, falls before hospitalization, use of technical aids, bedridden condition or not, iADL
- **Cognitive status**
  - MMSE, clock, brain scan, delirium
- **Social situation**
  - Type of home, family caregiver (spouse, children...), home caregivers (nurse, physiotherapist, meals delivery, home helper...)
- **Treatments**
  - Name and types of medications (benzodiazepines, neuroleptics, anticoagulants/anti-aggrégants, antidepressants).
- **Medical history**
  - Oncology, orthopaedic, endocrine, cardiovascular, neurology (stroke, dementia).
- **Number of examinations performed in emergency ward**
- **Reason for admission**
- **Sensory deficit**
- **What happens after hospitalization**
- **Proposed follow-up after stay**
- **Follow-up before and death during the stay**
- **Death at 1, 3 and 6 months after the end of the stay**
Primary outcomes were sociodemographic and clinical characteristics and secondary outcomes was profile.

Statistics

The sociodemographic and clinical characteristics were described by mean and standard deviation for quantitative variables, and frequencies and percentages for qualitative variables. The student’s t test was used for the analysis of quantitatively normally distributed variables and the Mann-Whitney test if the distribution was abnormal. Chi2 test (or Fisher’s exact test if the number in a group was less than 5) was used for qualitative variables. The analyses were considered statistically significant for any value of $p < 0.05$ (risk of type 1 error < 5%).

Results

Our population consisted mainly of women (69.8% in octogenarians and 75% in nonagenarians). The average age of the octogenarian group was 85.1 years and 92.2 years for the nonagenarian group. The most common reason for admission to our AGW was a neurological (acute confusion, convulsions, dysarthria, aphasia, hemiplegia, aggression or drowsiness (Figure 1). In our population, nonagenarians were more often hospitalized for cardiovascular problems ($p = 0.02$), but to a lesser extent for metabolic disorders ($p = 0.025$), compared to octogenarians.

We note that the nonagenarians were more often widowed and that the octogenarians are more at home (88.3% against 11.6% institutionalized). On the contrary, 32.6% of nonagenarians live at home against 67.3% in institutions (Figure 1). In our population, nonagenarians were more often followed before their stay ($p = 0.005$). Care was more supported by caregivers (81.2%) than in the octogenarian group (73.7%). We note however that the nonagenarians suffered from fewer blood tests ($p = 0.042$) and they had fewer emergency care exams ($p = 0.027$) and they were less isolated ($p = 0.015$). The deceased more often came from nursing homes ($p = 0.037$) and they were more bedridden ($p = 0.001$). The deceased more often came from nursing homes ($p = 0.037$) and they were more isolated ($p = 0.042$). They had fewer emergency care exams ($p = 0.027$) and they were less followed before their stay ($p = 0.015$).

In logistic regression, the variables related to death were male sex ($p = 0.020$) and their weight was greater ($p = 0.037$). They were bedridden ($p = 0.020$) and they benefited from fewer blood tests ($p = 0.02$) in emergency care. They were more often admitted for falls ($p = 0.049$) or urinary disorders ($p = 0.02$) and they were less followed before their stay ($p = 0.005$). Care was more limited ($p = 0.20$) and they were less eligible for intensive care ($p = 0.02$).

In our study did not reveal any significant difference between the two groups with regard to death during hospitalization, but nonagenarians die more at six months than octogenarians ($p = 0.009$).

The ISAR score of nonagenarians was lower than that of octogenarians ($p = 0.047$ for ISAR ≥4 and $p = 0.016$ for ISAR ≥ 5).

While the basic ADL were similar in the two groups, nonagenarians were more autonomous for iADL (22.5 on average) than octogenarians (26.1) ($p = 0.027$). The other mobility indicators such as the Tinetti test, the use of technical aids, the history of a fall before hospitalization or the bedridden status was not.

While the number of medications was similar in the two groups, the nonagenarians took significantly less antidepressants (21.1%, $p = 0.029$) than the octogenarian group (41.8%), but also less neuroleptics (3.8% against 16.2%, $p = 0.039$).

There was significantly more diabetics ($p = 0.028$) in the octogenarian group (37.2%) than in the nonagenarian group (17.3%). Even if the other types of history do not allow a further analysis, we note however that the nonagenarians suffered more from oncological and / or cardiovascular problems.

The ISAR score of nonagenarians was lower than that of octogenarians ($p = 0.047$ for ISAR ≥4 and $p = 0.016$ for ISAR ≥ 5).

In logistic regression, the variables related to death were male sex ($p = 0.020$), weight ($p = 0.037$), admission for fall ($p = 0.02$) or urinary disorders ($p = 0.02$). Finally, the lack of prior follow-up ($p = 0.02$) and the limited level of care ($p = 0.02$) Tables 1-4.
Table 1: Characteristics and comparison of the two populations.

| Measure                          | Octogenarians (SD, n = 43) | Nonagenarians (SD, n = 52) | p-value |
|----------------------------------|----------------------------|-----------------------------|---------|
| **Socio-demographic data**       |                            |                             |         |
| Average age                      | 92.2 (2.1)                 | 90.1 (2.6)                  | 0.001   |
| Woman [%]                        | 39 (75)                    | 30 (69.8)                   |         |
| Domicile before hospitalization [%] | 35 (67.3)                  | 38 (88.372)                 |         |
| Nursing home before hospitalization [%] | 17 (32.692)               | 5 (11.627)                  |         |
| Return home after hospitalization [%] | 23 (44.230)               | 20 (38.461)                 |         |
| Medical televigilance [%]        | 35 (67.3)                  | 33 (63.461)                 |         |
| Physiotherapist [%]              | 7 (13.4)                   | 9 (20.93)                   |         |
| Family [%]                       | 35 (67.3)                  | 36 (71.2)                   |         |
| Nurse [%]                        | 9 (17.3%)                  | 4 (8.89)                    |         |
| BMI (kg/m²)                      | 25.904 (5.943)             | 24.236 (4.578)              |         |
| Albumin (g/L)                    | 23.971 (5.849)             | 21.248 (4.777)              |         |
| Pre-albumin (mg/dL)              | 17.434 (6.434)             | 16.429 (5.849)              |         |
| CRP (mg/L)                       | 49.407 (56.112)            | 61.149 (12.800)             |         |
| Folate (µg/L)                    | 7.966 (6.718)              | 6.796 (5.943)               |         |
| Vitamin B12 (ng/L)               | 504.488 (356.6)            | 650.488 (423.726)           |         |
| **Nutritional status**           |                            |                             |         |
| Height (cm)                      | 161.93 (8.913)             | 160.571 (6.689)             |         |
| Weight (kg)                      | 67.694 (15.901)            | 62.7 (12.423)               |         |
| BMI (kg/m²)                      | 25.904 (5.943)             | 24.236 (4.578)              |         |
| MNA (score)                      | 7.461 (3.523)              | 7.33 (2.099)                |         |
| Albumin (g/L)                    | 29.283 (6.209)             | 32.183 (8.387)              |         |
| Pre-albumin (mg/dL)              | 16.22 (5.849)              | 17.248 (11.644)             |         |
| CRP (mg/L)                       | 49.407 (56.112)            | 61.149 (12.800)             |         |
| Folate (µg/L)                    | 7.966 (6.718)              | 6.796 (5.943)               |         |
| Vitamin B12 (ng/L)               | 504.488 (356.6)            | 650.488 (423.726)           |         |
| **Functional status**            |                            |                             |         |
| Bedridden n [%]                  | 3 (5.679)                  | 1 (2.325)                   |         |
| Use of technical aids (cane, walker) n [%] | 27 (51.923)              | 21 (48.837)                 |         |
| Falls in the year before hospitalization n [%] | 10 (19.230)               | 20 (39.130)                 |         |
| Tinetti test (n/28)              | 17 (32.692)                | 15 (29.130)                 |         |
| ADL-Lawton (n/36)                | 21.657 (6.288)             | 22.527 (7.549)              |         |
| **Treatment**                    |                            |                             |         |
| Number of drugs                  | 7.790 (2.891)              | 7.48 (3.083)                |         |
| Antiaggregants n [%]             | 14 (32.558)                | 24 (46.153)                 |         |
| Anticoagulants n [%]             | 11 (25.581)                | 17 (32.692)                 |         |
| Antidepressants n [%]            | 18 (41.860)                | 11 (21.153)                 |         |
| Long-acting benzodiazepines n [%] | 4 (9.302)                 | 6 (11.538)                  |         |
| Short-acting benzodiazepines n [%] | 11 (25.581)               | 17 (32.692)                 |         |
| Neuroleptics n [%]               | 7 (16.279)                 | 2 (3.846)                   |         |
| **Medical background**           |                            |                             |         |

Table 2: Global population analysis (nonagenarians and octogenarians) in relation to all deaths.

| Parameters                  | Living (n = 43) | Deceased (n = 52) | p-value |
|-----------------------------|----------------|------------------|---------|
| Age (years)                 | 88.389 (4.280) | 91 (3.896)       | 0.011   |
| CRP (mg/L)                  | 47.696 (60.551) | 87.248 (76.149) | 0.013   |
| Vitamin B12 (ng/L)          | 526.479 (340.893) | 765.318 (513.558) | 0.013   |
| Tinetti test (n/28)         | 17.229 (4.291) | 20.33 (5.545)    | 0.001   |
| Bedridden [%]               | 0              | 4 (17.391)       | 0.001   |
| Cerebral scan performed during hospitalization or in emergency ward [%] | 24 (33.3) | 3 (13.043) | ns |
| Place of residence          |                |                  |         |
| Before stay:                |                |                  |         |
| Home [%]                    | 59 (81.944)    | 13 (18.055)      | 0.037   |
| Nursing home [%]            | 14 (60.869)    | 9 (39.130)       |         |
| Family’s home [%]           | 61 (84.722)    | 15 (65.217)      | 0.042   |
| Number of exams             | 4.430 (1.480)  | 3.608 (1.947)    | 0.027   |
| Blood sample [%]            | 70 (97.22)     | 20 (86.956)      |         |
| Previous follow-up [%]      | 11 (25.777)    | 9 (39.130)       | 0.015   |

Table 3: Nonagenarian population analysis in relation to deaths during the stay (univariate).

| Parameters                  | Living (n = 43) | Deceased (n = 9) | p-value |
|-----------------------------|----------------|-----------------|---------|
| Sex [%]                     | 8 [18.6]       | 5 [55.5]        | 0.020   |
| Men                         | 35 [81.4]      | 4 [44.4]        |         |
| Weight (kg)                 | 61.149 (12.800) | 71.038 (6.360) | 0.037   |
| CRP (mg/L)                  | 54.74 (65.738) | 109 (99.5)      | ns      |
| Bedridden [%]               | 1 [2.3]        | 2 [22.2]        | 0.020   |
| Blood sample [%]            | 42 [97.7]      | 7 [77.77]       | 0.02    |
| Reason for admission:       |                |                 |         |
| Falls and FD [%]            | 20 [46.51]     | 1 [1.11]        | 0.049   |
| Urinary disorders [%]       | 1 [2.3]        | 2 [22.2]        | 0.02    |
| Previous follow-up [%]      | 6 [13.95]      | 5 [55.5]        | 0.005   |
| Level of care: Limited [%]  | 20 [46.51]     | 8 [88.89]       | 0.020   |
| Eligible for ICU [%]        | 23 [53.486]    | 1 [11.11]       | 0.02    |

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Discussion

As described in the introduction, the population of nonagenarians is growing more and more around the world and the coming decades will see this phenomenon amplify further with the arrival of the “baby boom” patients. However, despite research carried out in Belgium [10] and around the world [11,12], we lack data on this population. At a time of our health care system is uncertain, we need clinical information about this category of patients which generates significant social and health costs [11]. This study, like that of Petermans, et al. [10], attempts to demonstrate that nonagenarians have a different clinical profile from younger patients (octogenarians). The population studied could be considered as representative of that admitted to the AGW in Belgium.

Nonagenarian vs octogenarian

Sociodemographic data: Before analyzing the results, we expected our population to be fragile. However, the majority of patients (72.6%) are made up of women living at home before the hospitalization (76.8%). This is a similar observation to other studies around the world [12]. Compared to octogenarians, nonagenarians tend to be more often institutionalized before hospitalization (32.7% in our study). In an Italian cohort [13], they were only 11% (low number, in connection with the Mediterranean culture in which the elderly relative is kept as long as possible at his home or that of his children). In a Danish study [14], this number was 48%, much higher than in Italy.

As far as we are concerned, the intermediate value could be due to the peculiarities of the French-speaking Belgian population living in the province of Hainaut (mix between a population from northern Europe and the Mediterranean given the strong Italian immigration during the 20th century). In addition, nonagenarians are more often widowed, generally no longer having their family to help them (which perhaps explains a tendency to live more often in institutions) and they cook less (iADL supported by the nursing home).

Clinical data: Nutritionaly, nonagenarians seem to have a lower weight than octogenarians while the comparison of BMI does not show a significant difference. Other nutritional data including albumin and vitamin B12 levels do not allow clear conclusions to be drawn compared to the two groups. Indeed, it is complex to discuss the differences of nutritional biological elements while their results also depend on other parameters such as hydration or inflammation linked to the causes of acute hospitalization. Functionally, while the basic daily activities seem similar in the two groups, we observe a better autonomy concerning the iADL in the nonagenarians. Strange observation, especially since this group would reside more in institutions. Therefore, we might think that, ultimately, the reason for institutionalization does not lie in the performance of autonomy but rather in other etiologies. Perhaps there is a link between family support and place of residence? We still need to specifically study these interferences and their social implications.

Treatment: In our population, for the same number of medications, nonagenarians take significantly less antidepressants and neuroleptics. Astonishing observation, allowing only hypotheses: First, difficulties of evaluation in the elderly; depression remains underdiagnosed in nonagenarians [15], this phenomenon being more amplified with age, the lack of interest in looking for symptoms, the lack of consultation with a psychiatrist [16] or the general impression that it is “normal” to be sad at the age of ninety [17]; Secondly, the poor tolerance of these drugs, in particular according to comorbidities / polypharmacy [18], leading or precipitating a lack of compliance with the treatment [19]. Similar observation regarding the relationship between neuroleptics and behavioral disorders: modification of the spectrum of symptoms of the disease, progressing towards more apathy than psychosis [20], poor tolerance or feverishness in prescribing a neuroleptic in view of the great age. Finally, a final hypothesis would be the limited access to certain specialties such as psycho-geriatrics, hence the use of different treatment.

Medical background: Nonagenarians suffer significantly less from type 2 diabetes than octogenarians. Indeed, diabetes can be considered a negative factor in longevity [21] and its prevalence decreases with age due to higher mortality in people with glycemic disorders [22]. Finally, type 2 diabetes is less often diagnosed in the elderly [23]. Insulin resistance in very old patients could be the subject of further study: our nonagenarians being lighter than the octogenarians, would there not be an impact on the metabolism involving insulin sensitivity?

Reason for admission: In our sample, nonagenarians were admitted more often than octogenarians for cardiovascular problems (cardiac dyspnea, peripheric edema, myocardial ischemia or bleeding). As Mostaza JM, et al. pointed out in 2018 [24], with increasing life expectancy, the prevalence of cardiovascular disorders is higher in very old patients. However, they were less admitted for metabolic disorders (anemia) and with a certain trend for neurological disorders (acute confusion, convulsions, dysarthria/aphasia, hemiplegia, behavioral disturbances or excessive drowsiness). Surprising results given the prevalence of delirium as a reason for admission usually approaching 30% [25] (13% in our study). One hypothesis to explain this data would be the erroneous encoding as a reason for admission to emergency care and in the unit or the lack of recognition of delirium in the emergency ward [26].

 frailty: Based on the average ISAR, octogenarians are at greater risk of functional decline than nonagenarians. They

### Table 4: Logistic regression (incorporation of significant data in univariate).

| Variables        | Odds ratio |
|------------------|------------|
| Sex (man)        | 33.2       |
| Weight (kg)      | 1.2        |
| Reason for admission: |          |
| Falls and FD     | 0.5        |
| Urinary disorders| 2.3        |
| Previous follow-up | >50       |
| Level of care:   |            |
| Limited          | >50        |
| Eligible for ICU | ns         |

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more often have ISARs ≥4 and ≥5. Despite our research, we did not find any studies to support these results. Therefore, we could read these in relation to the iADL. Indeed, as described above, we found that nonagenarians, more institutionalized, are less dependent for iADL compared to octogenarians. In addition, it is obvious that losing autonomy is more frequent if the reserve is still present than if it is already lost.

**Mortality:** In our study, surprisingly, nonagenarians do not die more during hospitalization than octogenarians, but the mortality at 6 months for the former is higher. Despite a literature search that included the terms “nonagenarians”; “Mortality”; “Outcomes” using the PubMed, Google Scholar and Scopus databases, we found no literature regarding long-term mortality in nonagenarians after hospitalization. However, the risk of death for a nonagenarian, whether hospitalized or not, is de facto greater. On the other hand, this result could justify the hospitalization of a nonagenarian because he would not die more during the stay than an octogenarian. In addition, this result would also be interesting for adapting medical aggressiveness during treatment taking into account a short-term prognosis, similar between the two groups, while in the long term, the evolution of mortality, logically overwhelms the oldest. This could mean that our attitude to medical care during hospitalization should not be very different between the two populations, unless this attitude impacts a long-term perspective (> 6 months), which underlines the importance of an adapted level of care, including patient reflection.

**Analysis of the overall population (octogenarians and nonagenarians)**

**Total death:** In univariate analysis, we found a statistically significant difference between the survivors and the deceased patients, observing that the deceased group presents an older age, a more important CRP level, a higher vitamin B12 level, a more bedridden state with more institutionalization before their admission. We also note a more limited therapeutic plan in the deceased patients with fewer additional examinations in the emergency room (i.e., biology, CT-scan). These data are summarized in Table 3 and appear to be relatively consistent with clinical practice. We can, however, notice that the therapeutic plan is much more limited in patients who will die, which may suggest either a correct assessment of their overall prognosis, or unfortunately, an unjustified limitation of the aggressiveness of care that could be prejudicial to their survival. A more specific analysis should be carried out to answer this question of paramount human importance.

**Analysis of the population of nonagenarians who will die**

In nonagenarians, men are more at risk of dying than women, which seems logical since the theoretical life expectancy is basically higher for women. The weight of deceased patients is greater (men are generally heavier than women). Likewise, in the general population, the CRP in deceased nonagenarians is significantly more important and the limited therapeutic plan (without cardiac resuscitation and intensive care unit admission) is significantly related to the deceased population.

In logistic regression, the items linked to death that stand out are sex, follow-up prior to hospitalization and the therapeutic plan.

**Conclusion**

Our study documents the sociodemographic and clinical status of nonagenarians hospitalized in AGW in French-speaking Belgium (province of Hainaut).

Indeed, we observe characteristics specific to nonagenarians compared to younger patients (octogenarians) such as greater independence for iADL despite a trend towards more frequent institutionalization before stay, greater isolation and a lower prevalence of diabetes. While these two categories of patients take the same number of drugs, nonagenarians take fewer antidepressants and neuroleptics.

Finally, although the prognosis at 6 months of the latter is logically worse, they do not die more than octogenarians during hospitalization, which should motivate the medical care of these patients and urge practitioners not too quickly reduce the intensity of care for the nonagenarians, provided that their therapeutic plan has been discussed with them in view of the evolution after stay.

Finally, other studies are necessary to highlight in particular the risk factors of death of nonagenarians during hospitalization as well as in emergency room in order to adapt the management of this category of patients, which will continue to grow in the coming decades.

**Study limitation**

A small number of observations could have influenced the absence of differences in the groups in terms of the frequency of deaths in the hospital and some others variables.

The design of the study did not make possible to identify the risk factors for death during the stay.

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